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EXECUTIVE SUMMARY REPORT - FY80 GEOTECHNICAL SITING INVESTIGATI--ETC(U)
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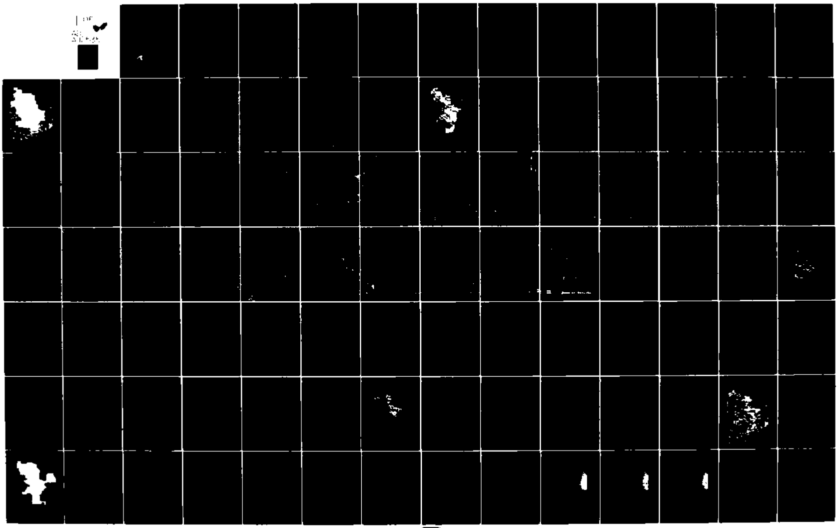

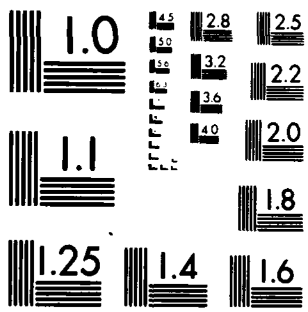
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Executive Summary Report

FY80 Geotechnical Siting Investigations

FUGRO NATIONAL, INC.
Consulting Engineers and Geologists

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This report contains a summary discussion of geotechnical programs that were conducted in FY 80 ~~in Nevada and Utah~~ for USAF - MX missile advanced ICBM program. The purpose is to provide other agencies with data needed.

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EXECUTIVE SUMMARY REPORT

FY 80 GEOTECHNICAL

INVESTIGATIONS

Prepared for:

U. S. Department of the Air Force
Ballistic Missile Office (BMO)
Norton Air Force Base, California 92409

Prepared by:

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Long Beach, California 90807

30 November 1980

FOREWORD

This report was prepared for the Department of the Air Force, Ballistic Missile Office (BMO), Norton Air Force Base, California, in compliance with Contract No. F04704-80-C-0006, CDRL Item 004A2. Summary discussions included in this report describe programs that were conducted in Fiscal Year 1980 (FY 80). Many of the FY 80 programs are continuations of studies begun in previous years. More details on these prior programs are included in reports listed in the Appendix and in two previous geotechnical summary reports:

- o Geotechnical Siting Status Report - 21 June 1978; and
- o Executive Summary Report, Geotechnical Siting Investigations, FY 79 - 26 October 1979.

The major FY 80 programs, in terms of scope and effort, are: Verification (Section 2.0), Water Resources (Section 3.0), Aggregate Resources (Section 4.0), Topographic Mapping (Section 5.0), and Layout Studies (Section 6.0). These programs are largely continuations of studies that were initiated in FY 79 to provide technical data to support MX siting decisions and to provide data needed by other MX associate contractors. Report sections 7.0 through 12.0 contain discussions of the other geotechnical studies performed in FY 80.

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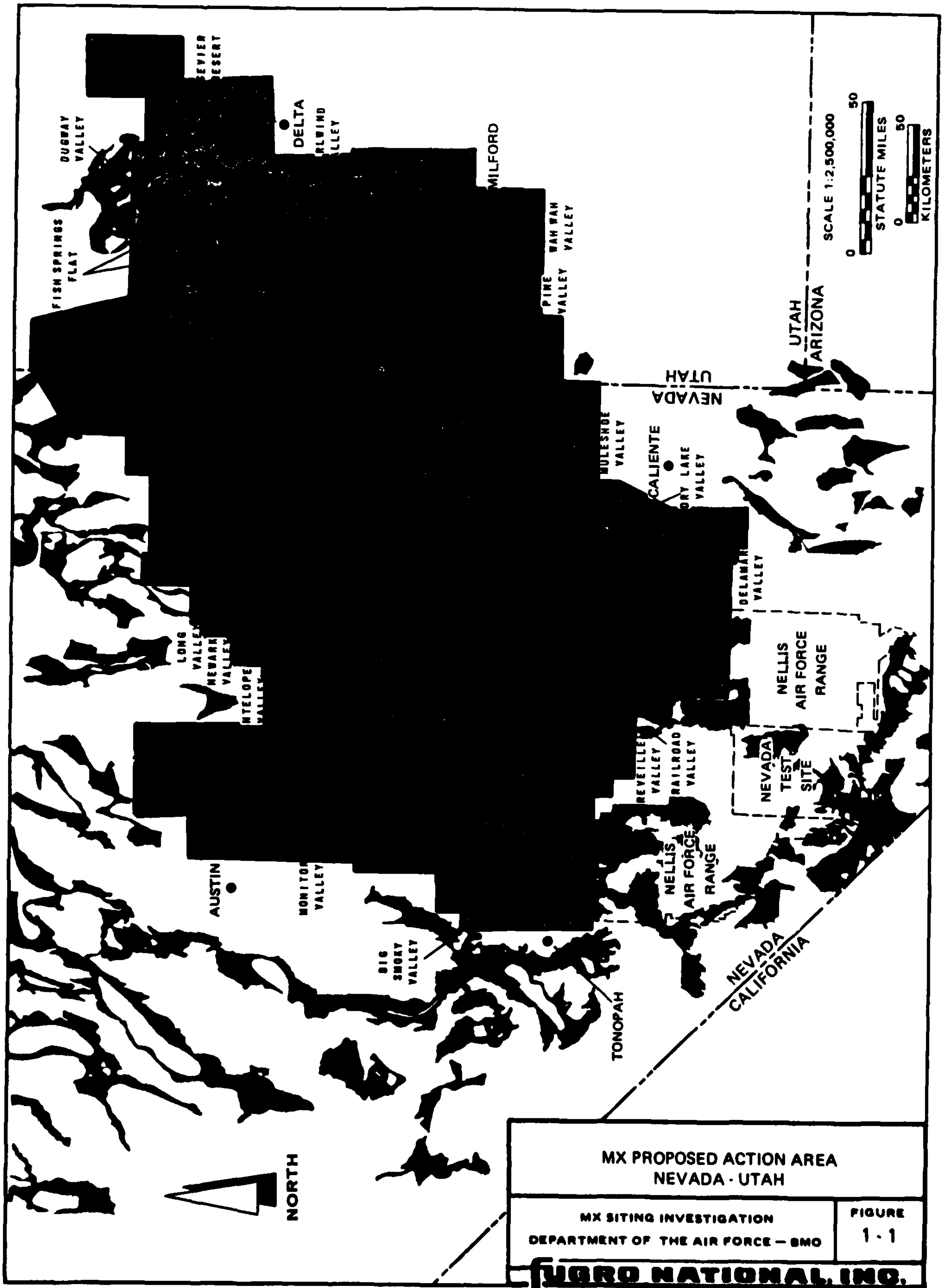
1.0 INTRODUCTION

This report contains summary discussions of the geotechnical programs that were conducted in Fiscal Year 1980 (FY 80) for the U. S. Air Force's (USAF's) Missile X (MX) advanced ICBM program. The purpose of the geotechnical studies is to provide technical information to support MX siting decisions and requirements and to provide data needed by other associate MX contractors and government agencies. Geotechnical studies performed in FY 80 are, in most instances, a continuation of studies begun in previous years, although a few new programs were initiated in FY 80. Brief descriptions of these programs are presented in this section, and more details are discussed in the following report sections.

All FY 80 programs were performed within the USAF's preferred siting area of Nevada and Utah and, more specifically, in the "proposed action area" of those two states (Figure 1-1). The proposed action area, as defined for the Environmental Impact Statement (EIS), is an aggregation of valleys or portions of valleys that are under consideration for possible deployment of the land-based MX system. Suitability of these valley areas for MX siting was originally defined in preceding geotechnical programs that were based on literature and very limited field work. Additional information regarding these previous studies, as well as other prior MX geotechnical programs, is included in reports that are listed in the Appendix.



MX PROPOSED ACTION AREA
NEVADA - UTAH

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE — BMO

FIGURE 1 - 1

FUGRO NATIONAL, INC.

26 NOV 80

Field studies were begun in the Nevada-Utah area in October 1978 and continued through FY 80. This effort, called Verification studies, is primarily for the purpose of verifying the suitability of areas that were identified in the prior literature-based studies. The Verification studies are scheduled for completion in FY 81. Verification study results provide more precise definition of the suitable area where MX shelters and supporting facilities can be sited. In addition, the results are used to guide the scope and location of the other geotechnical studies that are proceeding in Nevada and Utah.

Other geotechnical programs summarized in this report were conducted to provide specific technical data to satisfy various MX project needs. Briefly, these other programs are:

- Water Resources: A variety of office and field tasks designed to determine the quantity, quality, and location of water resources within the possible deployment areas. Data will be used to support water appropriation and determine the impact of water withdrawals.

- Aggregate Resources: Various office, laboratory, and field tasks to determine the quality and location of sand and gravel sources for MX road and facility construction. Both rock and valley-fill deposits are being evaluated.

- Topographic Mapping: The production of topographic maps at scales of 1:62,500 and 1:9600. The 1:62,500-scale maps are being made of those valleys where the existing largest scale maps are at 1:250,000. The 1:9600-scale maps are being made for the Initial Operational Capability (IOC) valleys and other valleys being considered in initial construction programs. Both scale maps are being used for shelter layout studies and field surveys.

- MX Layout Studies: Valley shelter layout studies at a scale of 1:62,500 to determine the number of clusters that can be located in each valley in the Designated Deployment Area (DDA). Layouts are also done at a scale of 1:9600 in selected valleys in support of the IOC program. Both scale layouts are being prepared to support the land withdrawal application.

- Field Surveys, IOC Valleys: Field surveys to locate and monument actual locations of shelters, Cluster Maintenance Facilities (CMFs), and Remote Surveillance Sites (RSSs) in three valleys. The sites are environmentally and geotechnically inspected and sites are relocated if necessary. The field program was started in September and is to be completed in the first quarter of FY 81.

- Operational Base (OB) Studies: Office and field tasks to determine geotechnical, cultural, and environmental characteristics of Strategic Air Command's (SAC's) five candidate OB sites.

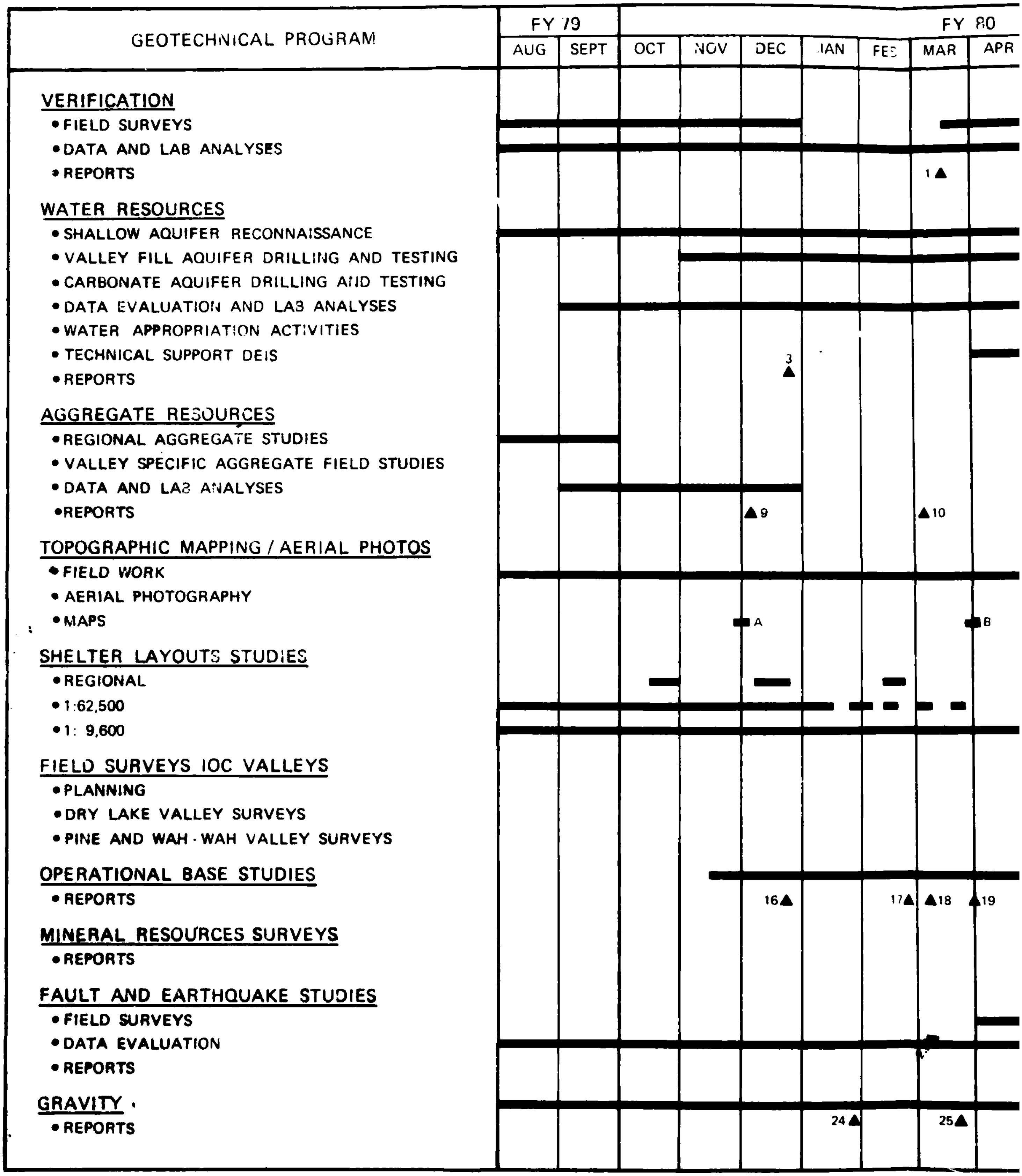
- Mineral Resources Survey: A survey to evaluate the mineral potential in the MX siting area in support of the land withdrawal application.

- Fault and Earthquake Hazards: Field and office studies to determine these hazards and impacts on MX layouts.

- Gravity Program: Geologic and geophysical analyses of gravity data collected in the valleys by the Defense Mapping Agency (DMA).

- Road Design and Mobility Test Studies: Various tasks to support design of MX roads.

The phasing, schedule, and important milestones for these programs in FY 80 are shown in Figure 1-2. Progress of the major field and layout tasks are presented in Figure 1-3.



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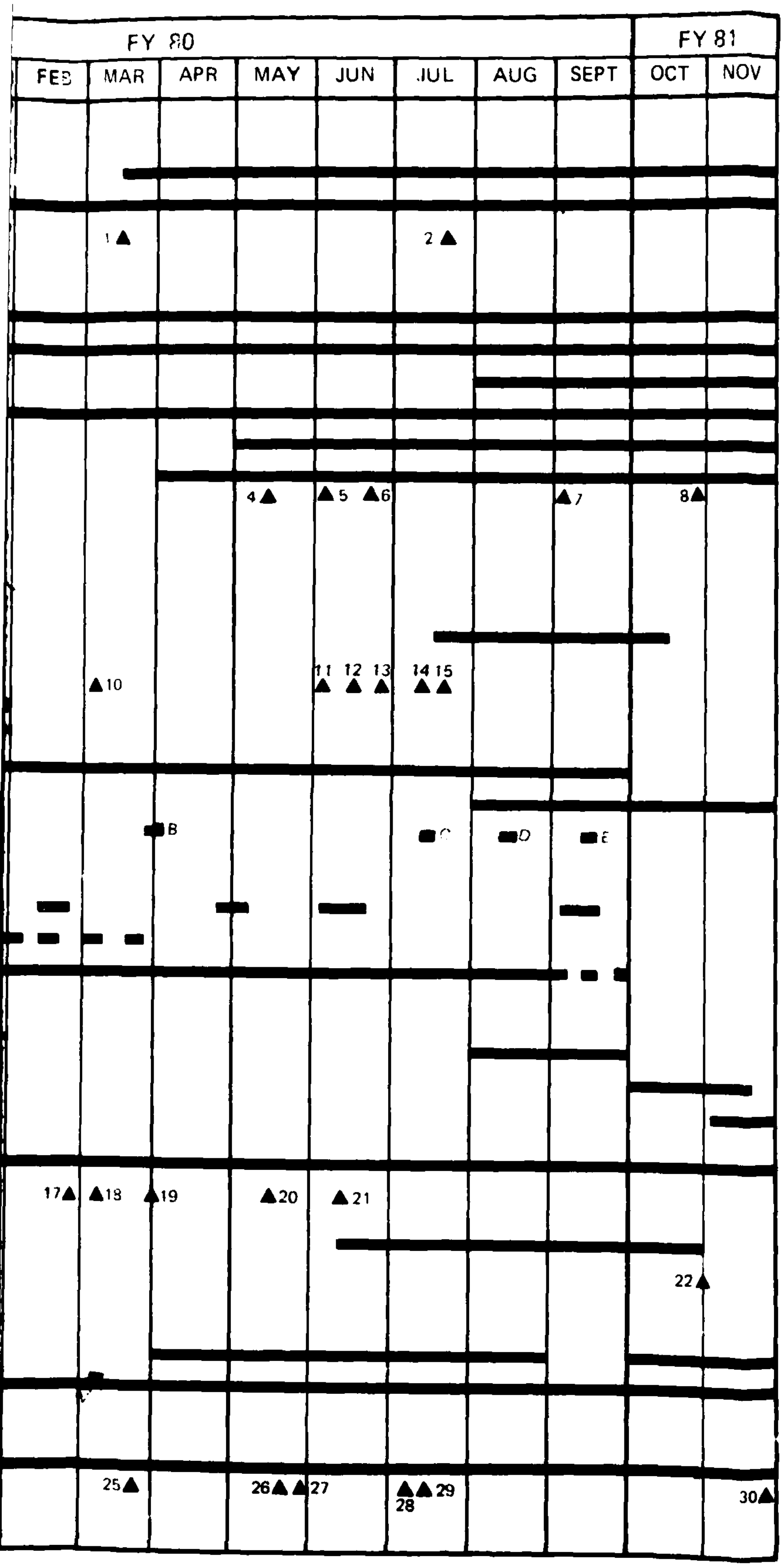

REPORTS (▲)

1. Verification Studies, Dry Lake Valley FN-TR-27d1
2. Verification Summary Report FN-TR-39
3. MX Siting Investigation, Geotechnical Summary Water Resources Program, FY 79
4. MX Siting Investigation Water Resources Program Summary for the DEIS (FN-TR-38)
5. MX Siting Investigation, Nevada and Utah Water Law and Procedures for Rights Acquisition, Water Resources Program FY 80
6. Municipal Water - Supply and Waste - Water Treatment Facilities in Selected Nevada and Utah Communities
7. MX Siting Investigation Water Resources Program Industry Activity Inventory, Nevada - Utah
8. MX Siting Investigation Water Resources Program Interim Report (FN-TR-40)
9. Aggregate Resources Summary Report FY 79
10. Aggregate Resources Report, Utah - Nevada Study Area FN-TR-34
11. Aggregate Resources Study Dry Lake, Muleshoe, Delamar, and Pahroc Valleys, Nevada FN-TR-37a
12. Aggregate Resources Study White River Valley, Nevada FN-TR-37c
13. Aggregate Resources Study Snake Valley, Utah - Nevada FN-TR-37b
14. Aggregate Resources Study Hamlin Valley, Nevada - Utah FN-TR-37d
15. Aggregate Resources Study Whirlwind Valley, Utah FN-TR-37e
16. Initial Operating Base Report FN-TR-35
17. Proposed Operational Base Site, Coyote/Kane Springs, Nevada FN-TR-35
18. Proposed Operational Base Site, Milford, Utah FN-TR-35
19. Proposed Operational Base Site, Ely, Nevada FN-TR-35
20. Proposed Operational Base Site, Delta, Utah FN-TR-35
21. Proposed Operational Base Site, Beryl, Utah FN-TR-35
22. MX - Mineral Resources Survey (Draft) FN-TR-41d
23. Interim Report on Active Faults and Earthquake Hazards, FN-TR-36

Gravity Reports

24. Whirlwind Valley Utah; Dry Lake Valley Nevada
25. Snake Valley, Utah
26. White River Valley, Nevada
27. Garden Valley, Coal Valley, Nevada
28. Hamlin Valley, Nevada
29. Hot Creek Valley, Nevada; Big Sand Springs, Nevada
30. Big Smoky Valley, Nevada

TOPOGRAPHIC MAPS:

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D. Wah Wah Valley, Utah (1:9600)
E. Garden/Coal, Railroad Valleys, Nevada (1:62,500)

FY 80 GEOTECHNICAL INVESTIGATIONS

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE — BMO

FIGURE 1 2

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2

STATUS OF MX SITING INVESTIGATION, GEOTECHNICAL EVALUATION OF NEVADA-UTAH STUDY AREA

VALLEY	NUMBER OF CLUSTERS: 1 JULY 1980 (REGIONAL LINEAR 5200 FOOT SPACING)	NUMBER OF CLUSTERS: 17 JULY 1980 (REGIONAL LINEAR 5200 FOOT SPACING)	NUMBER OF CLUSTERS: 2 SEPT 1980 (REGIONAL LINEAR 5200 FOOT SPACING)	NUMBER OF CLUSTERS: 26 SEPT 1980 (REGIONAL LINEAR 5200 FOOT SPACING)			VERIFICATION: FIELD WORK IN FY 80	VERIFICATION: FIELD WORK IN FY 81	AGGREGATE RESOURCES: FIELD WORK IN FY 80	AGGREGATE RESOURCES: FIELD WORK IN FY 81	AGGREGATE RESOURCES: FIELD WORK IN FY 82	WATER RESOURCES: SHALLOW AQUIFER RECONNAISSANCE: FIELD WORK IN FY 80	WATER RESOURCES: SHALLOW AQUIFER RECONNAISSANCE: FIELD WORK IN FY 81	DRILLING AND AQUIFER TESTING: SHALLOW: FIELD WORK IN FY 80	DRILLING AND AQUIFER TESTING: SHALLOW: FIELD WORK IN FY 81	DRILLING AND AQUIFER TESTING: INTERMEDIATE: FIELD WORK IN FY 80	DRILLING AND AQUIFER TESTING: INTERMEDIATE: FIELD WORK IN FY 81	CARBONATE (BEDROCK): FIELD WORK IN FY 80: DRILLING	CARBONATE (BEDROCK): FIELD WORK IN FY 80: TESTING	CARBONATE (BEDROCK): FIELD WORK IN FY 81: DRILLING	CARBONATE (BEDROCK): FIELD WORK IN FY 81: TESTING	TOPOGRAPHIC MAPS: 1:62,500 SCALE: WORK IN FY 80	TOPOGRAPHIC MAPS: 1:62,500 SCALE: WORK IN FY 81	TOPOGRAPHIC MAPS: 1:24000 SCALE: WORK IN FY 80	TOPOGRAPHIC MAPS: 1:24000 SCALE: WORK IN FY 81	FAULT STUDIES: STUDIES IN FY 80	FAULT STUDIES: STUDIES IN FY 81
UTAH																											
SEVIER	3	4	4	4			●				○	●														●	
DUGWAY	5	5	5	5			●				○	●		●												●	○
WHIRLWIND	11	11	11	11			●		●		○	●				⊕										●	
FISH SPRINGS	3	3	3	2			●					●			○											●	
TULE	12	12	12	9			●		●			●		●												●	
SNAKE	16	16	16	16			●		●			●										⊕				●	
WAH WAH	7	7	7	7			●		●			●				⊕				○	○			●	⊕	●	
PINE	4	5	5	5			●		●			●				●								●		●	
SEVIER LAKE	-	-	-	1																							
NEVADA																											
HAMLIN	10	10	9				●		●			●		●											○	●	○
SPRING	4	7	3	3			●			○		●		●												●	
LAKE	7	8	8	6			●		●			●													○	●	
MULESHOE	2	2	2	2			●		●			●					○							●		●	
DRY LAKE	10	10	10	10			●		●			●				●				○	○			⊕		●	○
DELAMAR	4	4	4	4			●		●			●				●								●		●	○
PAHROC	1	1	1	1			●		●			●					○							●		●	
STEPTOE	-	-	-	-			●			○		●						●	○							●	
CAVE	3	3	3	2			●		●			●				⊕		○						●		●	○
WHITE RIVER	9	9	9	8			●		●			●				●										●	○
COAL	6	6	6	6			●		●			●					○	⊕	○			●				●	○
GARDEN	6	6	6	6			●		●			●				⊕						●				●	
PENOYER	4	4	4	4			●				○	●										●				●	
RAILROAD	21	21	21	19			●				○	●		●								⊕				●	○
ANTELOPE	7	7	7	7				⊕			○	●			○											●	○
LITTLE SMOKY	3	3	3	3				⊕			○	●			○											●	○
BIG SAND SPRINGS	3	3	3	3			⊕				○	●					○									●	○
HOT CREEK	5	5	5	4			●					●		●												●	○
REVEILLE	4	4	4	2				⊕				●					○									●	
STONE CABIN	8	8	8	7				⊕				●															○
RALSTON	9	0	5	9				⊕				●														⊕	○
BIG SMOKY	13	0	0	13				⊕				●															○
MONITOR	0	1	1	3				○					○														○
KOBEH	0	6	6	6				○					○														○
NEWARK	0	0	0	1				○					○														○
LONG	0	3	3	1				○					○														○
BUTTE	0	4	4	4				○					○														○
JAKES	0	2	2	2				○					○														○

EXPLANATION

- ○ WORK PLANNED
- ⊕ WORK PARTIALLY COMPLETED
- ● WORK COMPLETED

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3	17 OCT 1980	[illegible]

STATUS OF MAJOR GEOTECHNICAL INVESTIGATIONS, NEVADA-UTAH STUDY AREA

MX SITING INVESTIGATION

DEPARTMENT OF THE AIR FORCE BMO

FIGURE 13

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2.0 VERIFICATION

2.1 BACKGROUND

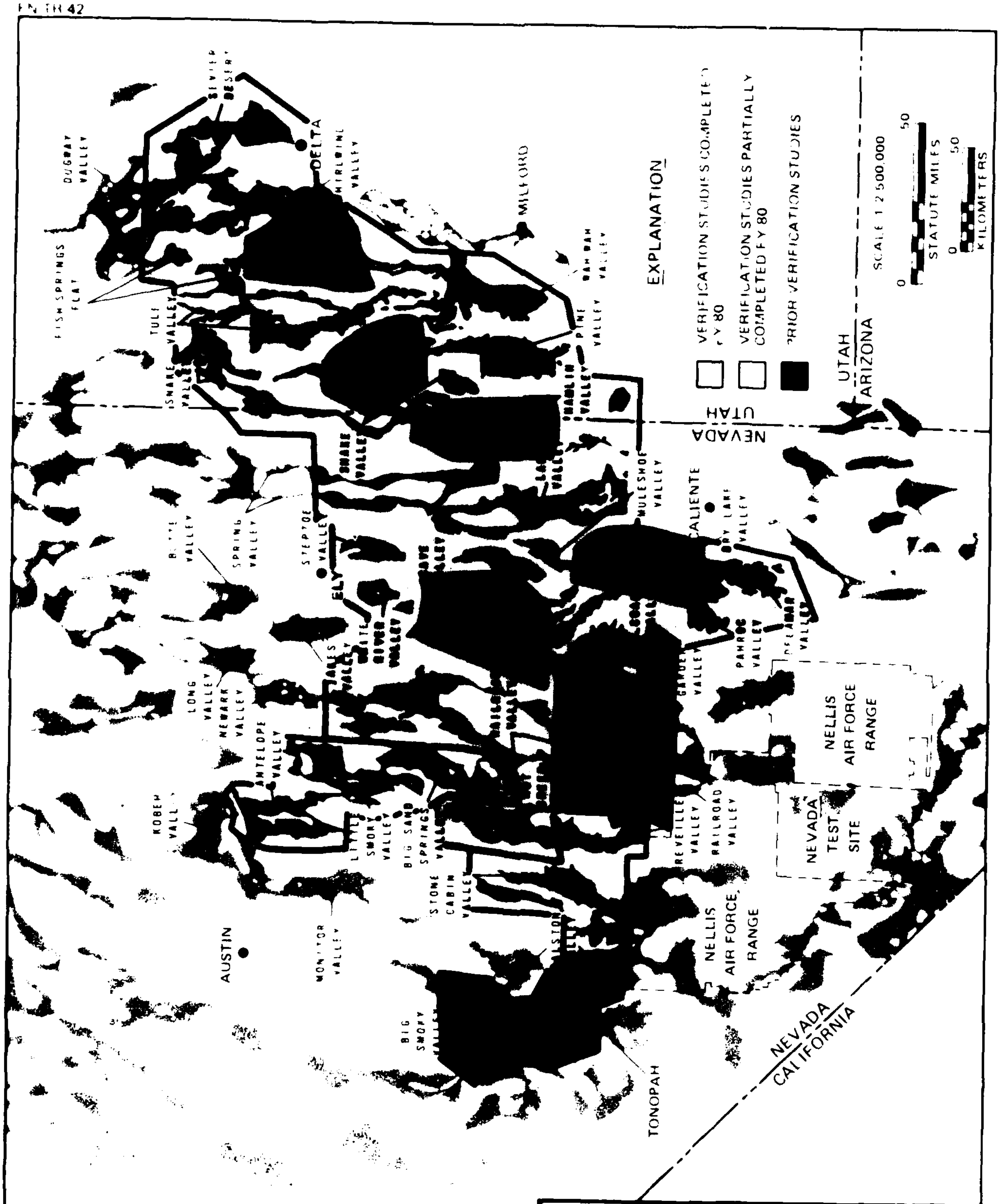
Verification field studies in Nevada and Utah were begun in October 1978. Prior to this time, approximately 20,000 square miles (mi^2) (51,800 square kilometers; km^2) of suitable area in Nevada and Utah had been identified during literature-based Screening studies. About 7700 mi^2 (19,900 km^2) of this area were selected as the study area during FY 79. At that time, field studies were performed and reports prepared for portions of seven valleys. During FY 80, field Verification studies were performed in additional valleys so that by the end of FY 80, Verification studies had been completed in 24 geographical valleys (Figure 2-1).

Reports incorporating results from Verification studies and preceding Characterization studies in Dry Lake and Ralston valleys were also published during FY 80. Reports for the other aforementioned valleys will be published during FY 81 and FY 82. In addition, a summary report (with regional map) of the Verification studies performed in early FY 80 was published in July 1980. A map of geotechnically suitable area incorporating the results of all aforementioned reports and data evaluated up to the date of this report is included as Drawing 2-1.

2.2 OBJECTIVES

The Verification studies in Nevada-Utah have the following objectives:

1. Verify and refine boundaries of suitable area;
2. Obtain geologic, geophysical, and engineering data for preliminary design studies;



FY 80 NEVADA-UTAH STUDY AREA
STATUS OF VERIFICATION STUDIES

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

FIGURE 2

FUGRO NATIONAL, INC.

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3. Identify problem areas where additional field work will be necessary; and

4. Recommend additional sites for study in Nevada-Utah to ensure that there is sufficient suitable area to deploy the MX system.

Verification studies consist of a combination of geologic, geophysical, and soils engineering investigative techniques designed to differentiate suitable and unsuitable area and obtain basic information on soil and terrain characteristics. The geotechnical parameters evaluated and techniques used are shown schematically in Table 2-1. Table 2-2 lists the type and number of geotechnical activities performed to date in each valley.

Prior to starting the Verification field studies, a program plan is developed, logistics are planned, and photogeologic mapping initiated. Access is arranged through state and district offices of the U.S. Bureau of Land Management (BLM) in Nevada and Utah. At BLM's request, all field activities are performed along existing roads or trails to minimize disturbance to the sites. Activity locations are changed in those few instances where a potential environmental or archaeological disturbance is identified.

2.3 SCOPE

The FY 80 Verification program consisted of three major elements:

1. Pre-Verification studies;
2. Basic Verification studies, and
3. Data Gap studies.

APPROVED BY

CHECKED BY

DRAWN BY

COMPILED BY

OBJECTIVES → VERIFICATION OF INTERMEDIATE FINE SCREENING SUITABL

DATA FOR EVALUATIONS → TERRAIN PARAMETERS | 50' 150' DEPTH TO ROCK | DEPTH

FIELD TECHNIQUES AND APPLICATIONS →

TERRAIN PARAMETERS

Geologic mapping

- Identification and limits of areas with slopes greater than 10% grade
- Identification and limits of areas with high incidence of 10% slopes (rolling terrain)

50' 150' DEPTH TO ROCK

Geologic mapping

- Surface limits of rock
- Subsurface limits of rock from topographic and geologic interpretation
- Geomorphic expression and erosion history

Seismic refraction surveys

- Subsurface projection of rock limits
- Delineation of rock from high (>>7000 fps) p-wave velocities

Borings

- Occurrence of rock

Gravity profiles (DMA)

- Overall basin shape and relationships
- Range bounding faults

Existing data

- Published literature

DEPTH

Existin

- Avail inter

Borings

- Occur

Electric seismic

Provi to su absen

Geologic

- Obtai wells

ITABLE AREA

CHARACTERISTICS OF BASIN FILL

50' 150'
DEPTH TO GROUND WATER

isting data

- Available well records and interpretation

rings

- Occurrence of ground water

ectrical resistivity
ismic refraction surveys

- Provide supplemental data to support presence or absence of ground water

ologic mapping

- Obtain water depths from wells encountered in field

EXTENT AND
CHARACTERISTICS OF SOILS

Geologic mapping

- Extent of surficial soil units
- Surficial soil types

Borings

- Identification of subsurface soil types
- In situ soil density and consistency
- Samples for laboratory testing

Trenches, test pits, and surficial samples

- Identification of surface and subsurface soil types
- Degree of induration and cementation of soils
- In situ moisture and density of soils
- Samples for laboratory testing

Cone penetrometer tests

- In situ soil strength

Laboratory tests

- Physical properties
- Engineering properties - shear strength, compressibility
- Chemical properties

GEOPHYSICAL PROPERTIES

Seismic refraction surveys

- Compressional wave velocities

Electrical resistivity surveys

- Electrical conductivity of soils
- Layering of soil

ROAD DESIGN DATA

Trenches, test pits, and Surficial samples

- Identification of soil types
- In situ soil density and moisture
- Thickness of low strength surficial soil

Cone penetrometer tests

- In situ soil strength
- Thickness of low strength surficial soils

Laboratory tests

- Physical properties
- Compaction and CBR data
- Suitability of soils for use as road subgrade, subbase or base

Existing data

- Suitability of soils for use as road subgrade, subbbase, or base
- Behavior of compacted soils

2

OF BASIN FILL

RECOMMENDATIONS FOR FUTURE VERIFICATION STUDIES

ROAD DESIGN DATA

Trenches, test pits, and Surficial samples

- Identification of soil types
- In situ soil density and moisture
- Thickness of low strength surficial soil

Cone penetrometer tests

- In situ soil strength
- Thickness of low strength surficial soils

Laboratory tests

- Physical properties
- Compaction and CBR data
- Suitability of soils for use as road subgrade, subbase or base

Existing data

- Suitability of soils for use as road subgrade, subbbase, or base
- Behavior of compacted soils

EXCAVATABILITY AND STABILITY

Borings

- Subsurface soil types
- Presence of cobbles and boulders
- In situ density of subsurface soils
- Stability of vertical walls

Trenches and test pits

- Subsurface soil types
- Subsurface soil density and cementation
- Stability of vertical walls
- Thickness of low strength surficial soils
- Presence of cobbles and boulders

Laboratory tests

- Physical properties
- Engineering properties

Geologic mapping

- Distribution of soil types

Seismic refaction surveys

- Excavatability

FIELD TECHNIQUES VERIFICATION STUDIES

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

TABLE 2-1

FUGRO NATIONAL, INC.

VALLEY	GEOLOGIC MAPPING STATIONS	SEISMIC REFRACTION MEASUREMENTS	ELECTRICAL RESISTIVITY SOUNDINGS	GRAVITY SURVEYS	BORINGS	TRENCHES AND TEST PITS	CONE PENETROMETER TESTS (CPT)	FIELD CBR TESTS
ANTELOPE	64	14	14	0	*	*	*	*
BIG SAND SPRINGS	77	16	14	1	*	*	*	*
BIG SMOKY	118	18	18	1	6	38	80	19
CAVE	56	10	10	0	4	16	20	0
COAL	83	15	15	1	5	35	61	0
DELAMAR	79	13	12	0	5	24	37	0
DRY LAKE	60	17	17	1	19	47	84	0
DUGWAY	69	21	20	1	5	30	48	0
FISH SPRINGS FLAT	59	17	14	0	4	13	29	0
GARDEN	45	16	15	1	6	34	43	0
HAMLIN	101	31	30	1	9	54	91	0
HOT CREEK	61	12	9	1	5	35	*	0
LAKE	123	22	20	0	7	54	102	2
LITTLE SMOKY	80	11	10	0	*	*	*	*
MULESHOE	48	10	9	0	3	17	24	0
PAHROC	49	7	7	0	3	18	28	0
PENOYER	90	18	15	0	4	*	*	*
PINE	86	23	22	0	10	44	86	15
RAILROAD	296	42	41	0	14	88	171	19
RALSTON	112	28	27	1	19	8	*	*
REVEILLE	43	12	12	0	5	20	*	*
SEVIER DESERT	99	25	24	1	10	59	99	0
SNAKE	255	56	54	1	18	91	165	0
SPRING	134	29	27	0	9	42	71	2
STEPTOE	45	12	11	0	4	23	*	4
STONE CABIN	84	23	22	0	8	19	*	*
TULE	221	48	45	0	11	74	128	0
WAH WAH	73	22	22	0	7	40	71	8
WHIRLWIND	180	39	38	1	12	66	122	0
WHITE RIVER	141	44	43	1	12	63	123	0
TOTALS	3031	671	637	13	224	1052	1683	69

*COMPILATION IN PROGRESS

Laboratory tests are performed on samples selected from borings, trenches, and test pits. These tests include sieve analysis, plasticity, in situ dry unit weight, moisture content, compaction, specific gravity, triaxial compression, unconfined compression, direct shear, consolidation, chemcial, and CBR.

VERIFICATION FIELD ACTIVITIES TO DATE	
MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE — BMO	TABLE 2-2

FUGRO NATIONAL, INC.

2.3.1 Pre-Verification Studies

Pre-Verification studies were performed in those valleys identified as having marginal value for MX deployment due to the possible presence of geotechnical exclusions occupying large portions of the valley. The exclusions, identified from existing literature gathered during Screening studies, are commonly shallow ground water and, to a limited degree, shallow rock. These exclusions have the effect of fragmenting the suitable area into isolated parcels or narrow and linear suitable area bands along the valley margins. The pre-Verification field studies were designed to provide data so that an early assessment of the valley's overall suitability could be made. The field activities consisted of drilling ground-water observation wells and performing seismic refraction surveys. Pre-Verification studies were performed in the following valleys:

1. Fish Springs Flat;
2. Snake (northern portion);
3. Lake; and
4. White River (southern portion).

After analyzing the data from the pre-Verification studies, the boundaries of suitable area in these valleys were revised. Full-scale basic Verification studies were later performed in the suitable area portions of these valleys when it was determined that they could accommodate one or more clusters.

2.3.2 Basic Verification Studies

The basic Verification studies were performed in new valleys as well as in portions of the FY 79 Verification valleys in which

no field work had previously been done. By the end of FY 80, Verification studies had been performed in the following valleys:

1. Dugway	11. Lake	21. Penoyer
2. Tule	12. White River	22. Steptoe
3. Fish Springs	13. Dry Lake	23. Hot Creek
4. Whirlwind	14. Delamar	24. Stone Cabin*
5. Snake	15. Muleshoe	25. Railroad
6. Hamlin	16. Pahroc	26. Sevier Desert
7. Pine	17. Garden	27. Antelope*
8. Wah Wah	18. Coal	28. Little Smoky*
9. Spring	19. Reveille*	29. Big Sand Springs*
10. Cave	20. Big Smoky*	30. Ralston*

* Verification studies partially completed.

2.3.3 Data Gap Studies

Evaluation of the data collected in FY 79 and the first quarter of FY 80 resulted in identifying certain valleys in which additional field work was necessary to more accurately define the boundaries of suitable area. These studies were termed "Data Gap studies" and consisted of drilling ground-water observation wells and performing seismic refraction surveys.

The Data Gap studies were performed in the following four valleys: 1) Whirlwind, 2) Snake, 3) White River, and 4) Hamlin.

2.4 RESULTS

2.4.1 Suitable Area

As in FY 79, the Verification studies resulted in significant changes to the boundaries of the suitable area of many valleys. The presence of shallow rock, shallow ground water, and/or adverse terrain accounted for most of the changes.

Changes in the suitable area for all the valleys in the study area are listed in Table 2-3. In addition, a revised map of suitable area is presented in Drawing 2-1.

2.4.2 Basin-Fill Material Characteristics

2.4.2.1 Surficial Soils

Surface soils are predominantly coarse-grained (granular) consisting of sand and gravel. Fine-grained soils (silt and clay) exist over limited portions of most sites. The surficial soils are combined into three categories based on their physical and engineering properties:

1. Silty sand and clayey sand: Predominant surficial soil occurring primarily in alluvial fans which extend from the basin margin to the basin center or playa edge.
2. Gravel and gravelly sand: These are the second most predominant surficial soil type. They consist of sandy, silty and clayey gravel, and sand with appreciable gravel content.
3. Silt and clay: These are the least extensive surficial soils. They consist of sandy silt and clay and silty clay with appreciable amounts of fine sand.

2.4.2.2 Subsurface Soils

Soils in the subsurface are predominantly coarse-grained (gravel and sand). Fine-grained soils (silt and clay) probably occur in about ten to 15 percent of the subsurface.

The coarse-grained soils are generally dense to very dense below depths of approximately 10 feet (3 meters; m). They exhibit low compressibilities and possess moderate to high shear strengths. The fine-grained soils exhibit low to high plasticity and generally contain appreciable amounts of fine sand. Variable calcium carbonate cementation exists in the subsurface soils.

VALLEY	STATE	SUITABLE AREA (MI²) HORIZONTAL SHELTER		
		BEGINNING AREA *	RESULTING AREA **	AREA CHANGE
ANTELOPE	NEVADA	245	135	−110
BIG SAND SPRINGS	NEVADA	235	210	− 25
BIG SMOKY	NEVADA	680	610	− 70
CAVE	NEVADA	135	115	− 20
COAL	NEVADA	275	240	− 35
DELAMAR	NEVADA	180	180	0
DRY LAKE	NEVADA	360	310	− 50
DUGWAY	UTAH	170	135	− 35
FISH SPRINGS FLAT	UTAH	155	135	− 20
GARDEN	NEVADA	230	200	− 30
HAMLIN	NEVADA-UTAH	425	335	− 90
HOT CREEK	NEVADA	185	240	+ 55[1]
LAKE	NEVADA	460	340	−120
LITTLE SMOKY	NEVADA	340	250	− 90
MULESHOE	NEVADA	100	85	− 15
PAHROC	NEVADA	105	95	− 10
PENOYER	NEVADA	285	265	− 20
PINE	UTAH	165	265	+100[1]
RAILROAD	NEVADA	790	730	− 60
RALSTON	NEVADA	420	385	− 35
REVEILLE	NEVADA	200	145	− 55
SEVIER DESERT	UTAH	225	410	+185[1]
SNAKE	NEVADA-UTAH	625	700	+ 75[1]
SPRING	NEVADA	210	265	+ 55[1]
STEPTOE	NEVADA	105	90	− 15
STONE CABIN	NEVADA	390	390[2]	0[2]
TULE	UTAH	540	390	−150
WAH WAH	UTAH	50	240	+190[1]
WHIRLWIND	UTAH	430	450	+ 20[1]
WHITE RIVER	NEVADA	625	485	−140
	TOTALS	9340	8825	−515

* FROM INTERMEDIATE SCREENING

** AT END OF FY 80

1 VALLEY GEOGRAPHIC BOUNDARIES WERE EXPANDED DURING FY 80

2 FIELD VERIFICATION IN PROGRESS

CHANGES IN HORIZONTAL SHELTER SUITABLE AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE — BMO

TABLE 2 3

FUGRO NATIONAL, INC.

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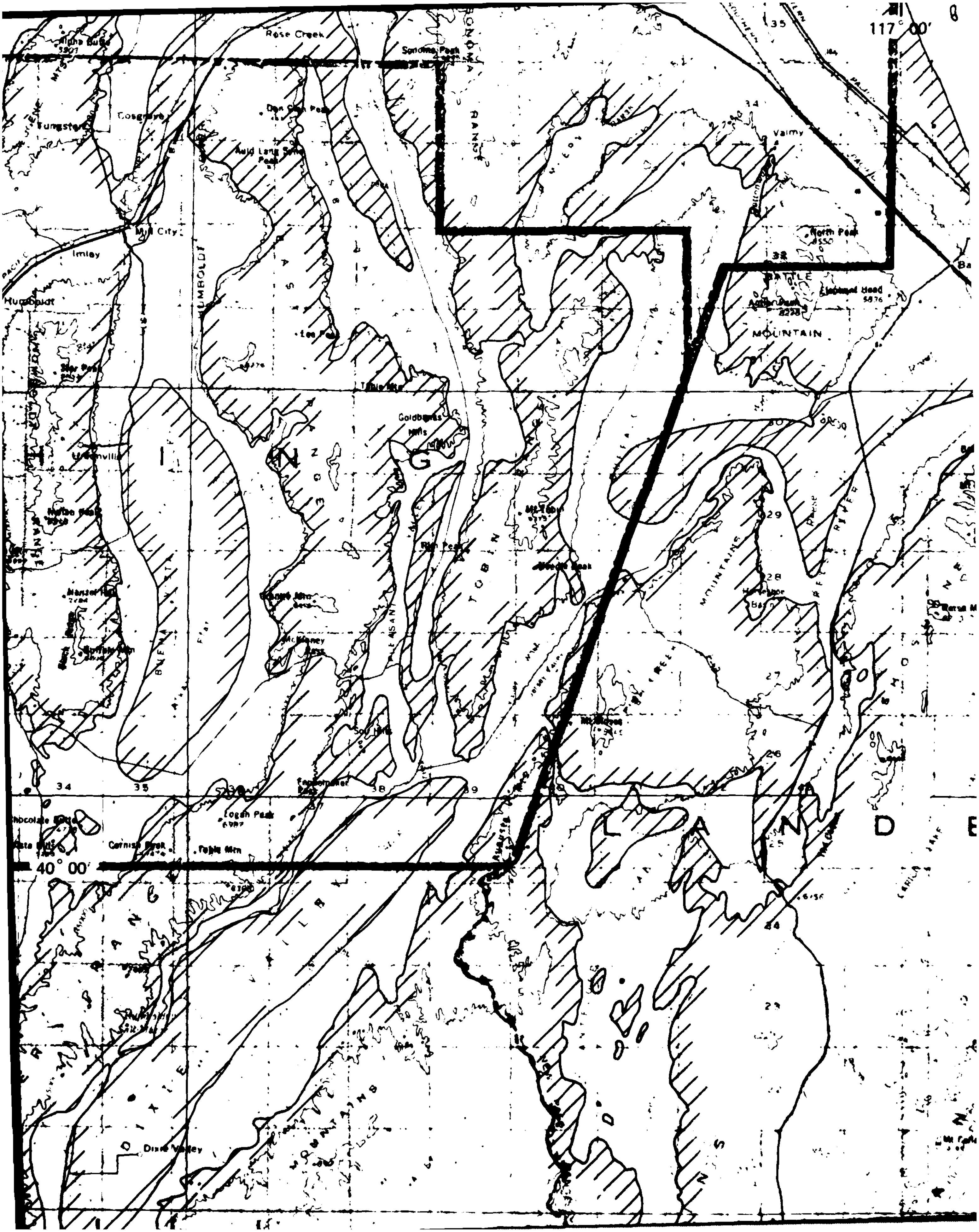
3.0 WATER RESOURCES PROGRAM

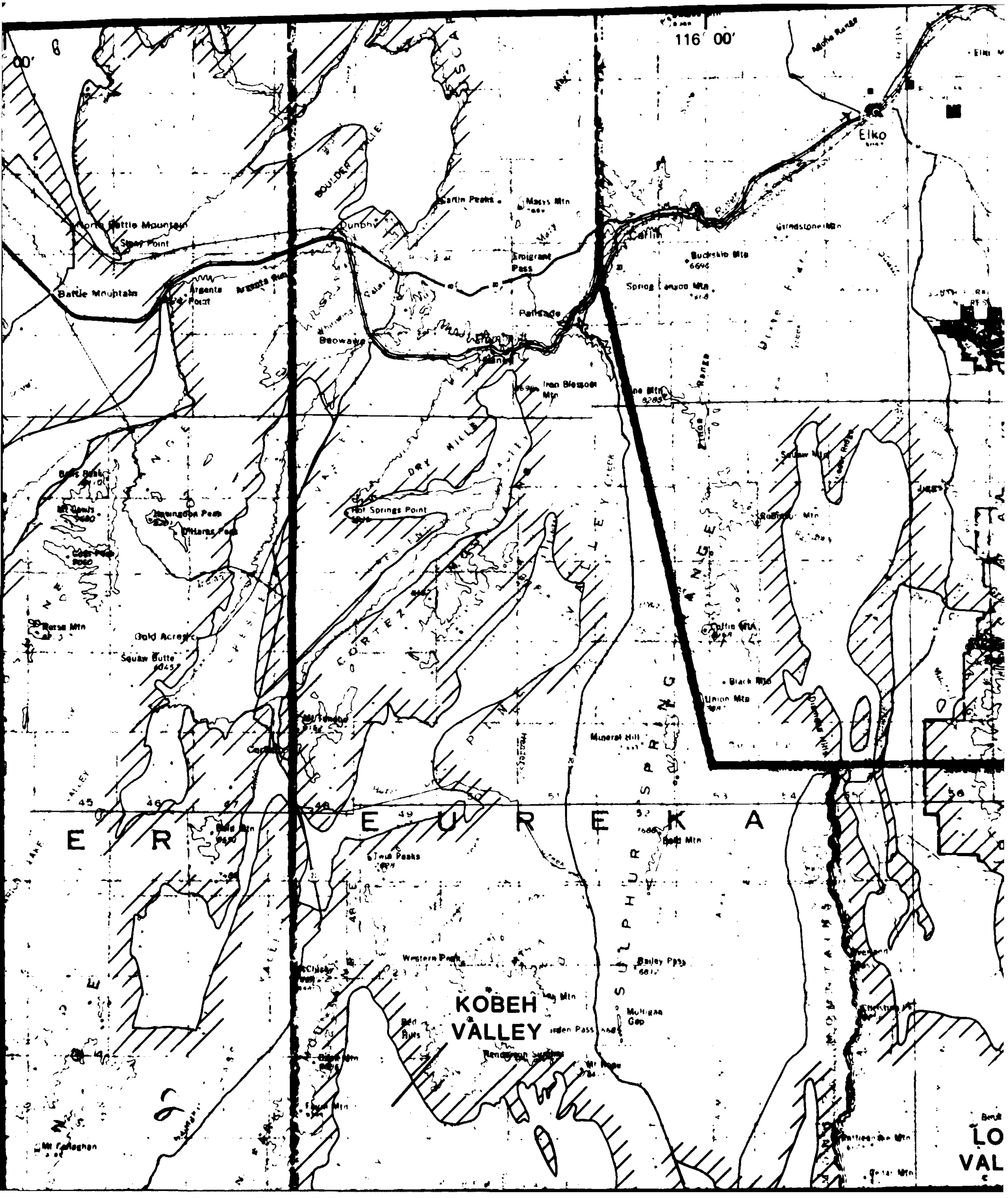
3.1 BACKGROUND AND OVERVIEW

The MX Water Resources Program was initiated in June 1979 for the purpose of evaluating the availability of water for both the construction and operational phases of the MX project. Six valleys representative of typical hydrologic conditions in the siting area were studied during FY 79, and a report was submitted to the Ballistic Missile Office (BMO) on 21 December 1979 (FN-TR-38). Based on the FY 79 studies, it was determined that the Water Resources Program should be expanded to include aquifer testing and field investigations in all valleys within the siting area in order to better understand the potential effects of MX ground-water withdrawals on the local water users and the environment and to determine the optimum water-supply system for the project. The Water Resources Program was expanded during FY 80 to include the investigation of the hydrologic conditions in 23 valleys in addition to the six valleys studied during FY 79.

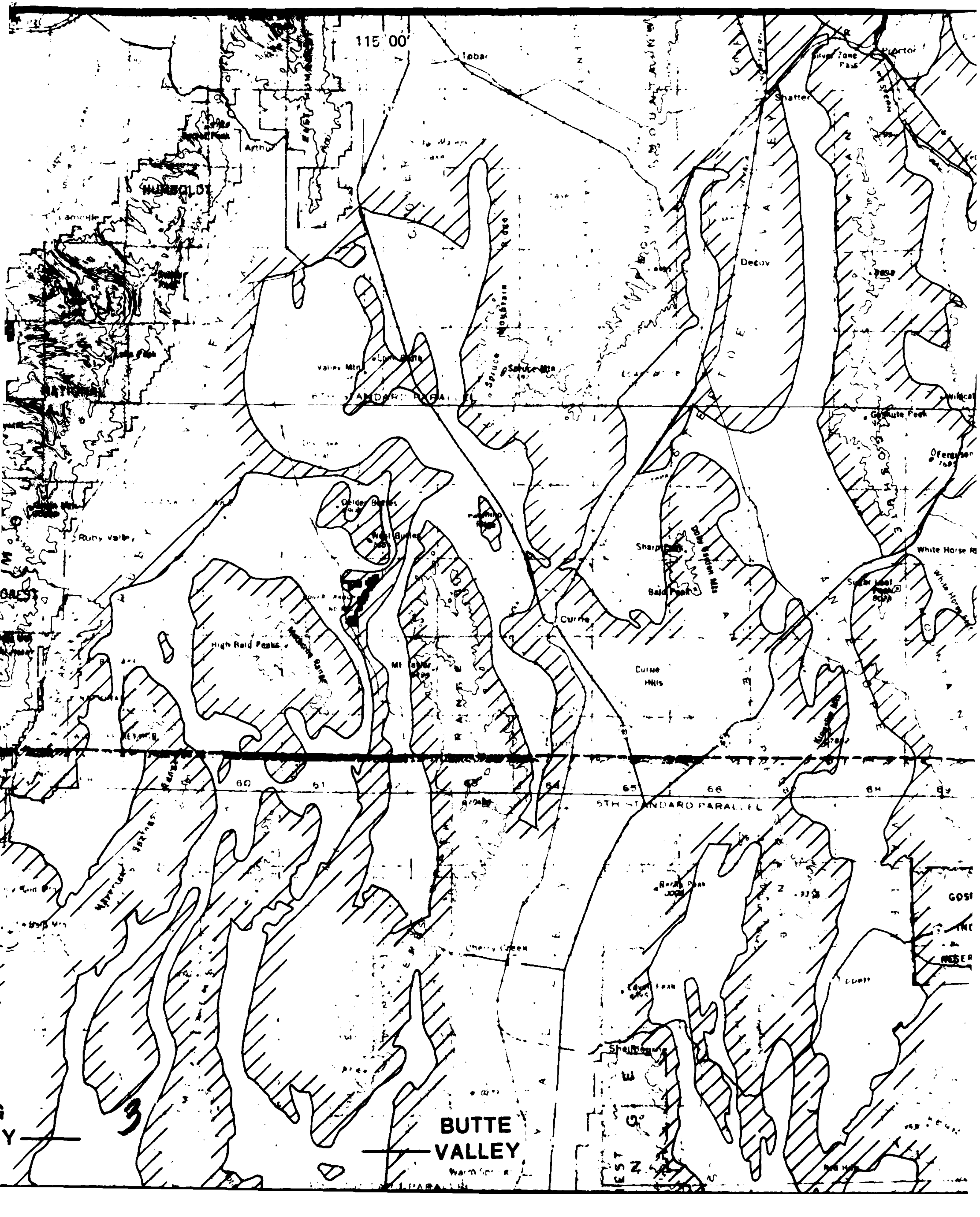
The results of the investigation of 16 valleys, including the six previously reported during FY 79, were presented to the Air Force Regional Civil Engineer-MX (AFRCE-MX) on 15 May 1980 in a report titled "MX Siting Investigation, Water Resources Program, Summary For Draft Environmental Impact Statement" (FN-TR-38). This report (FN-TR-38) includes all preliminary findings of the Water Resources Program conducted to 1 April 1980. Also included in that report are the results of a

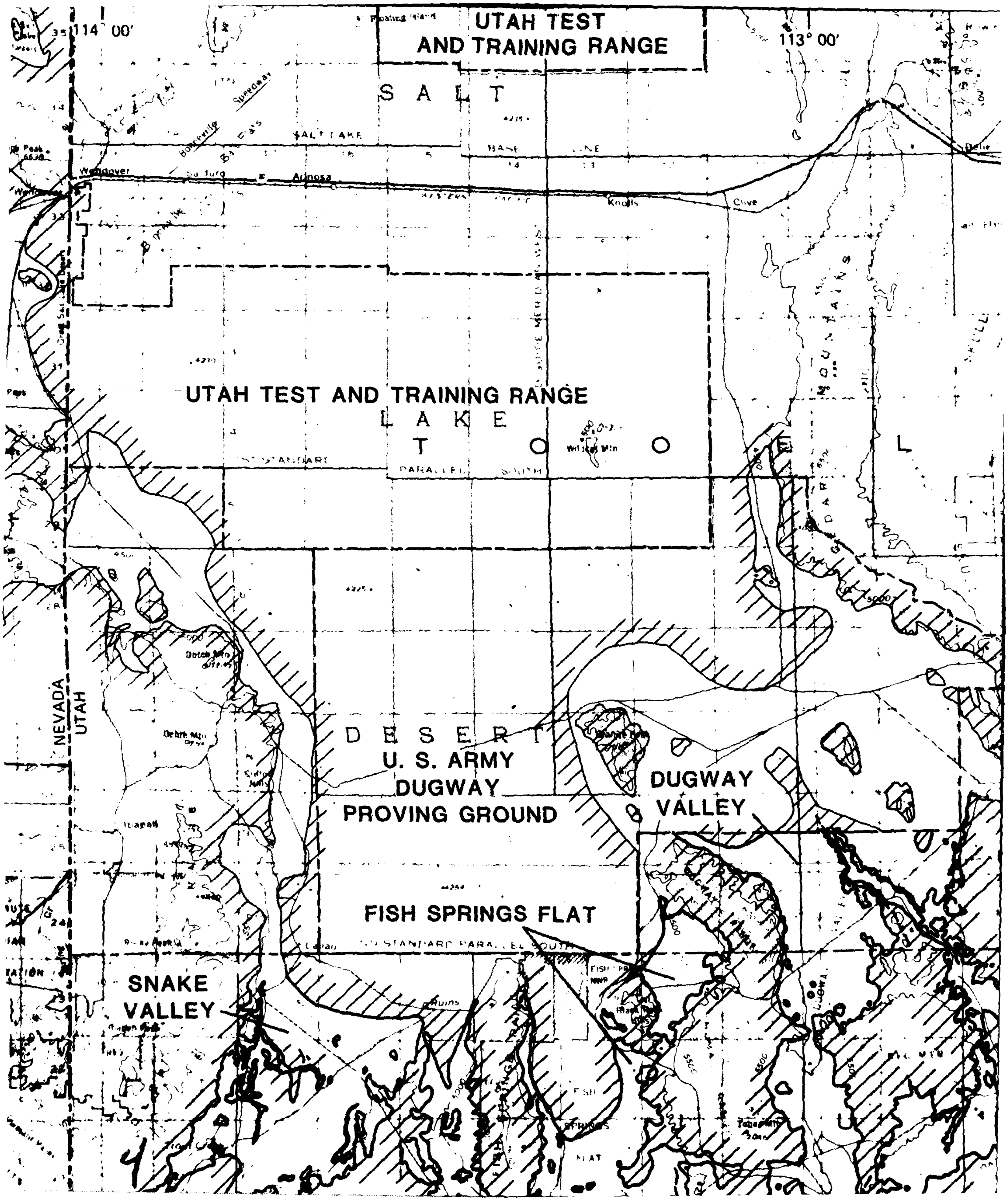


117° 00'
40° 00'
Rose Creek
Sonoma Peak
Tungsten
Cosgrave
Don Carr Peak
Auld Lang Syne Peak
Mill City
Imlay
Humboldt
HUMBOLDT
Valmy
North Peak
BATTLE
MOUNTAIN
Antler Peak
Lee Peak
Table Mtn
Goldbanks Hills
Unionville
Star Peak
Mt Tobin
TOBIN
Hanzel Mtn
Buffalo Mtn
McKinney Pass
Sou Hills
Horseshoe Basin
MOUNTAINS
Mt Moses
Chocolate Butte
Logan Peak
Cornish Peak
Table Mtn
Dixie Valley

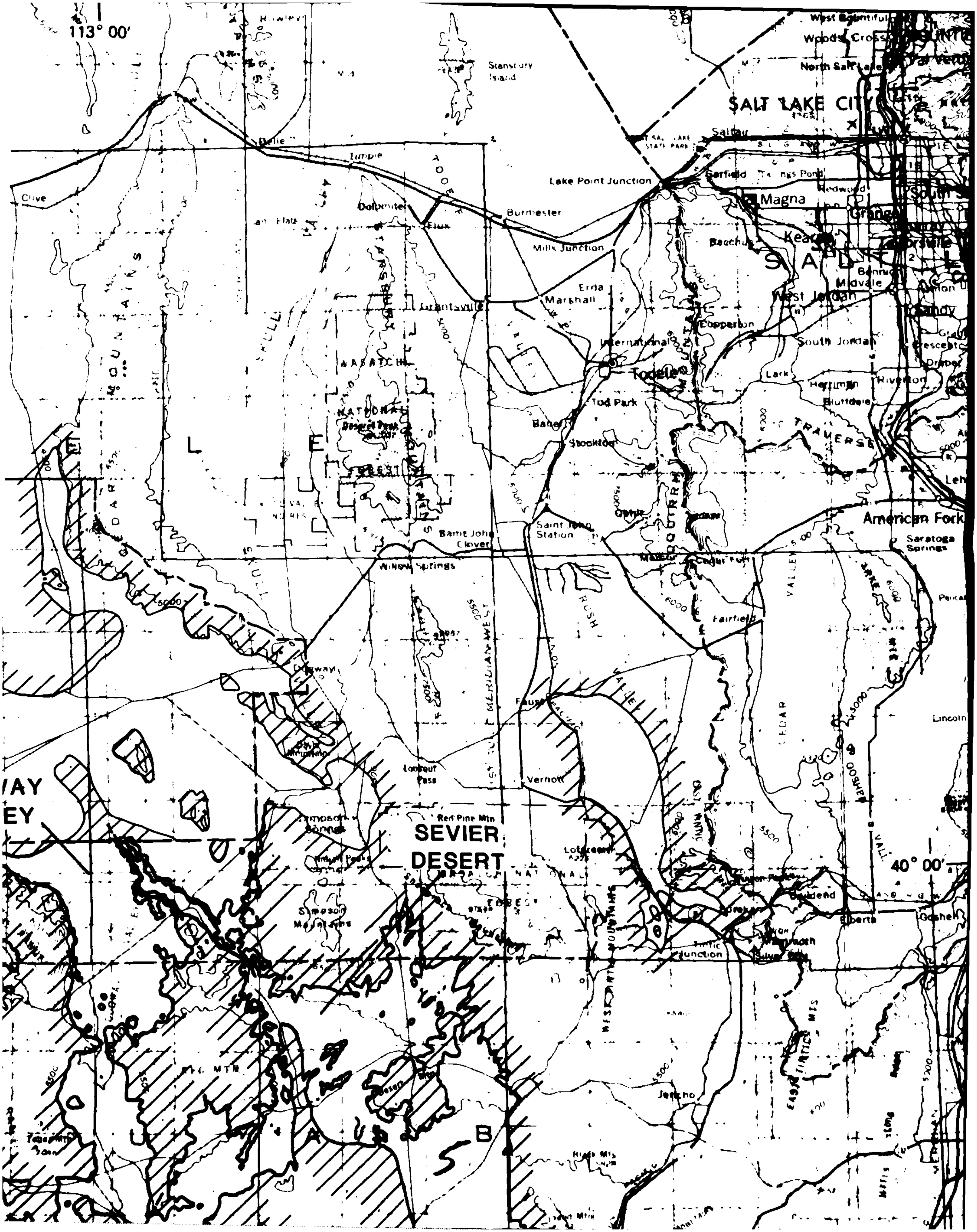


116° 00'
Elko
North Battle Mountain
Battle Mountain
Argenta
Dunphy
BOULDER VALLEY
Carlin Peaks
Emigrant Pass
Carlin
Buckskin Mtn
6696
Grindstone Mtn
Palisade
Beowawe
Iron Blossom Mtn
DRY HILLS
Hot Springs Point
CORTEZ
Gold Acres
Squaw Butte
Squaw Mtn
Coffin Mtn
Black Mtn
Union Mtn
Mineral Hill
Jiggs
45
46
47
48
49
51
52
53
54
56
E R
E U R E K A
Bald Mtn
Twin Peaks
Western Peak
Bailey Pass
6817
KOBEH
VALLEY
Mulligan
Gap
Mt Callaghan
LO
VAL

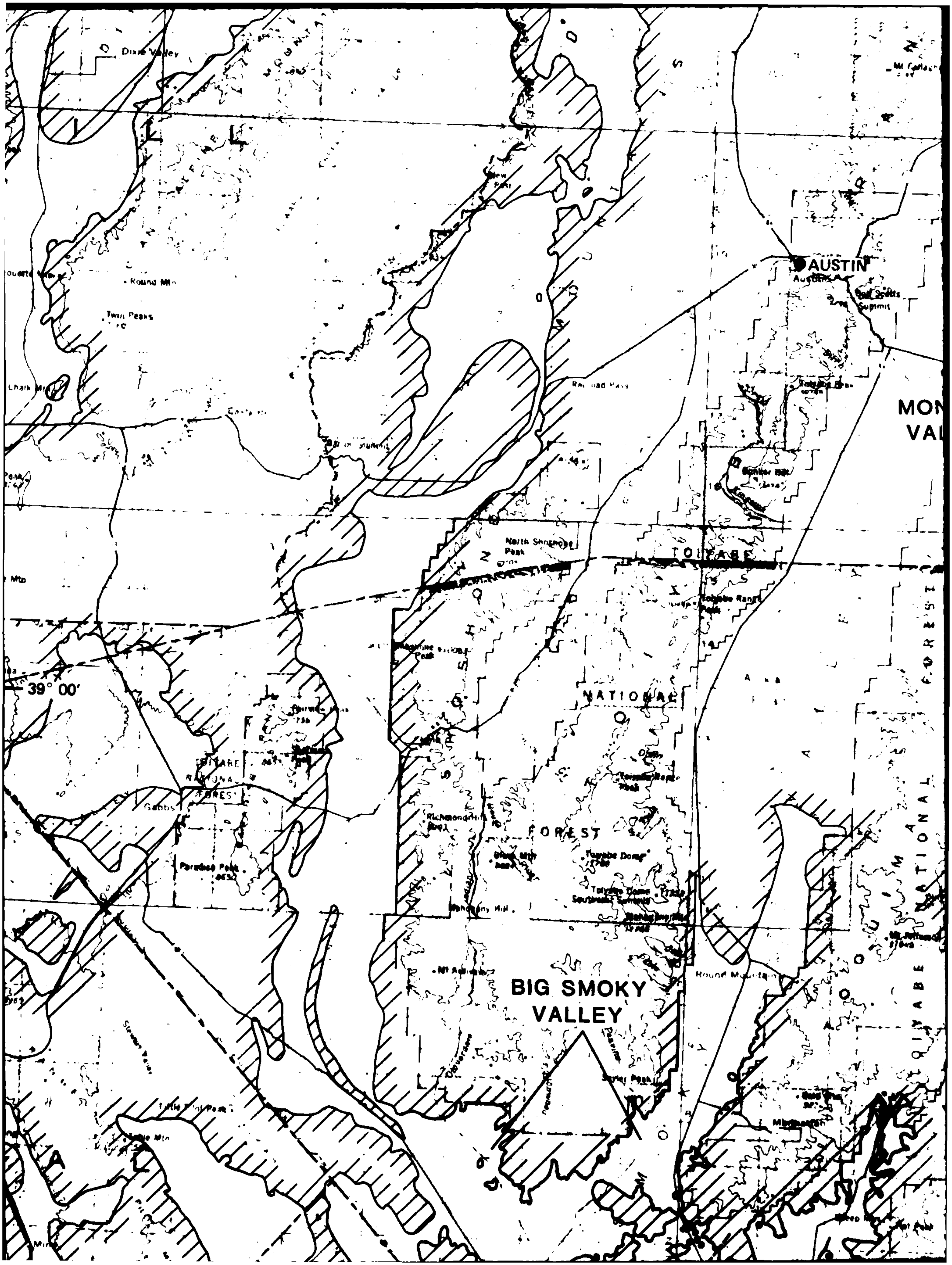

115 00'
Tobar
Silver Zone Pass
Proctor
Shafter
Arthur
HUMBOLDT
Lamoille
Decoy
Valley Mtn
Spruce Mtn
Spruce Mountain Ridge
STANDARD PARALLEL
Goshute Peak
Ruby Valley
Sharp Peak
Dolly Varden Mts
Bald Peak
White Horse Pass
Sugar Loaf Peak
Currie
High Bald Peaks
Currie Hills
60
61
64
65
66
5TH STANDARD PARALLEL
Cherry Creek
GOSI
Shellbourne
BUTTE VALLEY
Warm Springs



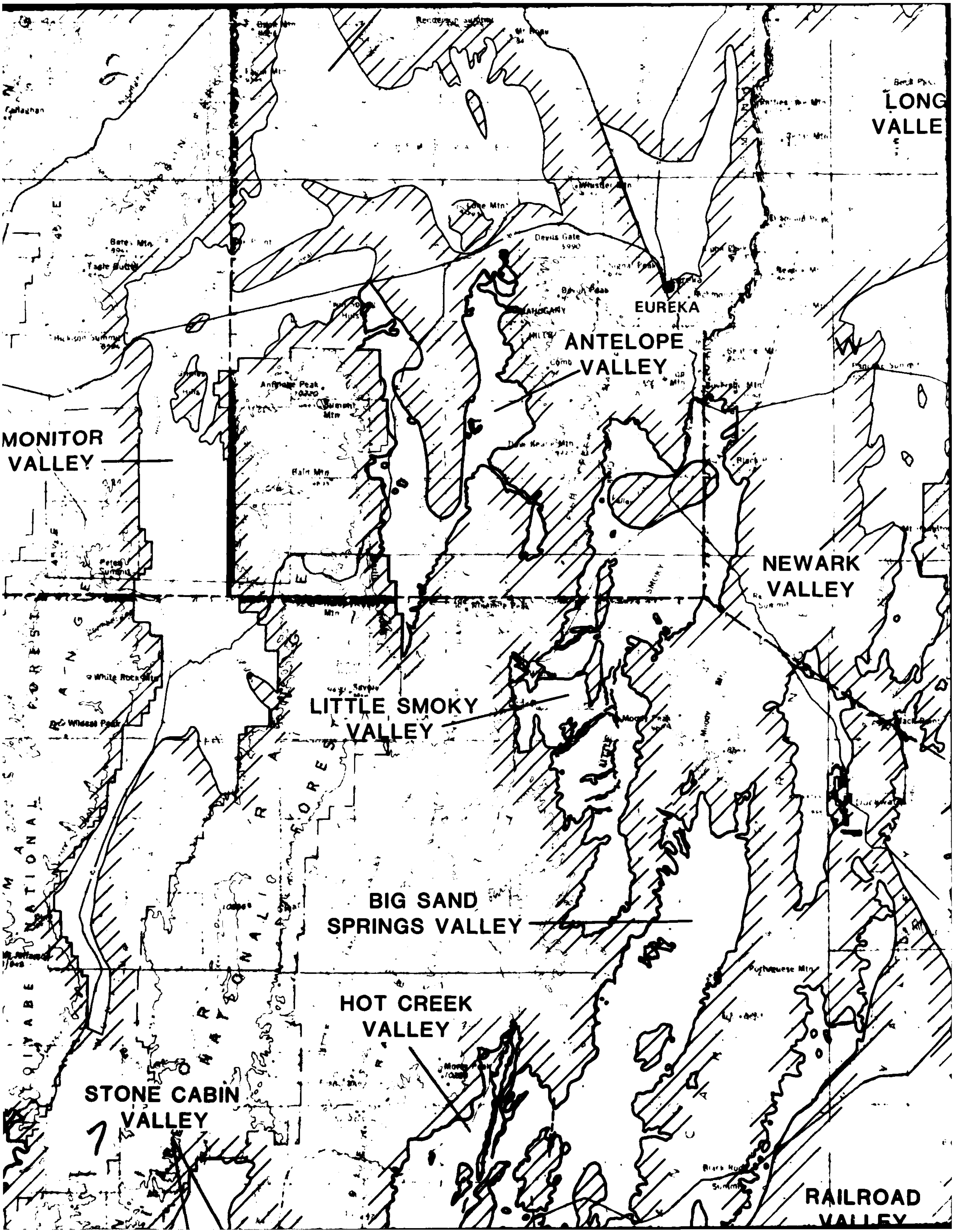
UTAH TEST AND TRAINING RANGE
114° 00′
113° 00′
SALT
LAKE
Wendover
Arinosa
Knolls
UTAH TEST AND TRAINING RANGE
T O O L
Wilson Mtn
NEVADA
UTAH
DESERT
U. S. ARMY DUGWAY PROVING GROUND
DUGWAY VALLEY
FISH SPRINGS FLAT
SNAKE VALLEY
Ruins

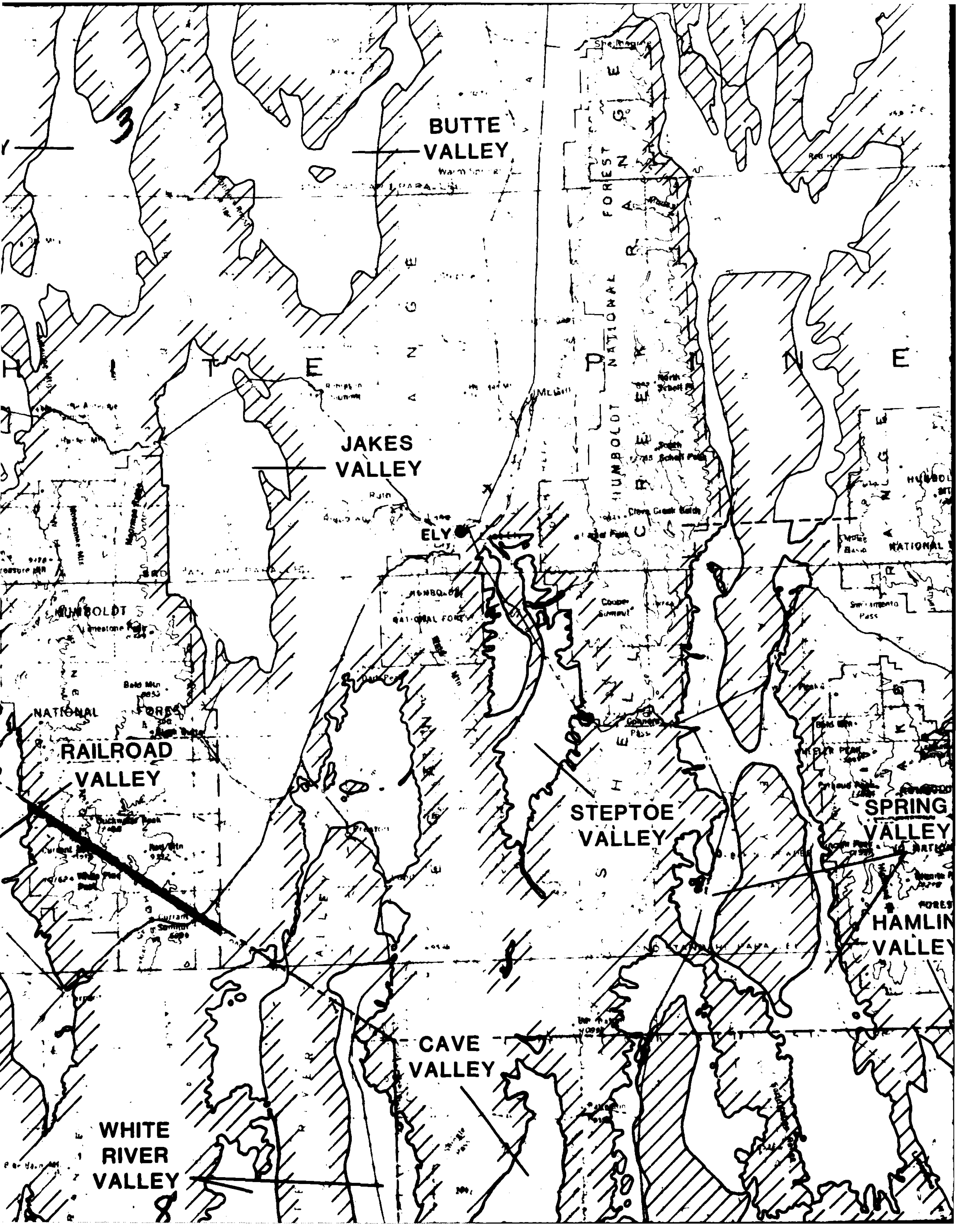


113° 00′
Stansbury Island
West Bountiful
Woods Cross
North Salt Lake
SALT LAKE CITY
Saltair
Belle
Timpie
Clive
Lake Point Junction
Garfield
Magna
Redwood
Granger
Dolomite
Burmester
Flux
Mills Junction
Bacchus
Kearns
Midvale
Erda
Marshall
West Jordan
Grantsville
Copperton
South Jordan
Sandy
International
Tooele
Lark
Herriman
Riverton
Draper
Bluffdale
WASATCH
NATIONAL
FOREST
Tod Park
Bauer
Stockton
TRAVERSE
MOUNTAINS
L
E
Ophir
American Fork
Saint John
Clover
Saint John Station
Mercur
Cedar Fort
Saratoga Springs
Willow Springs
RUSH
6000
Fairfield
5000
Dugway
MERIDIAN
Faust
Lincoln
CEDAR
VALLEY
Lookout Pass
Vernon
WAY
EY
Red Pine Mtn
Simpson Springs
SEVIER
DESERT
Lofgreen
40° 00′
NATIONAL
FOREST
Simpson Mountains
Tintic Junction
Eureka
Mammoth
Silver City
Elberta
Goshen
Dividend
WEST TINTIC MOUNTAINS
EAST TINTIC MTS
Jericho
B
S

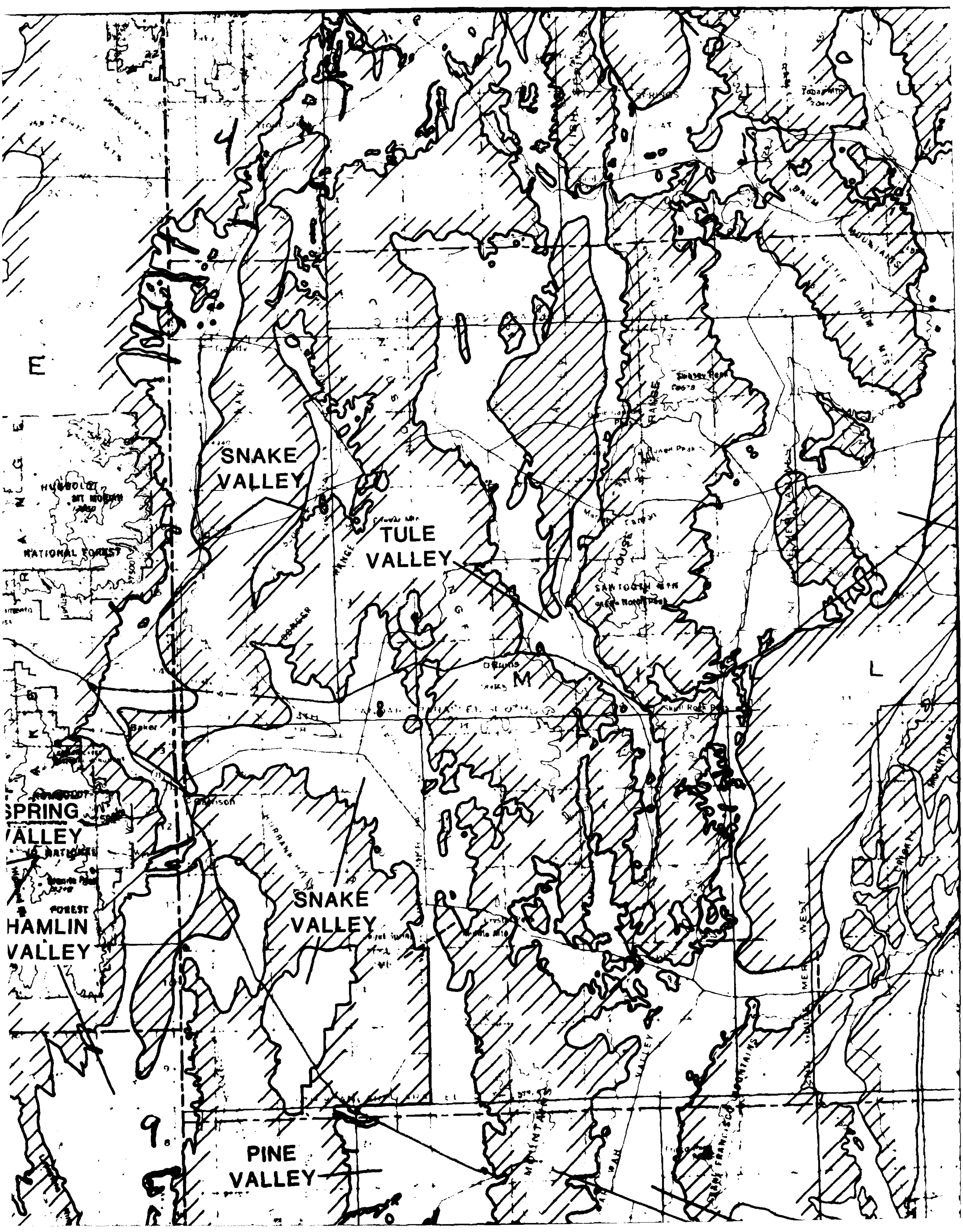


Dixie Valley
AUSTIN
Austin
Railroad Pass
MON
VAL
Round Mtn
Twin Peaks
Chalk Mtn
North Shoshone Peak
TOIYABE
Toiyabe Range Peak
39° 00'
NATIONAL
Gabbs
Richmond Hill
FOREST
Toiyabe Dome
Paradise Peak
Toiyabe Dome Southeast Summit
Mahogany Hill
Mt Airy
BIG SMOKY
VALLEY
Round Mountain
Manhattan
Sable Mtn

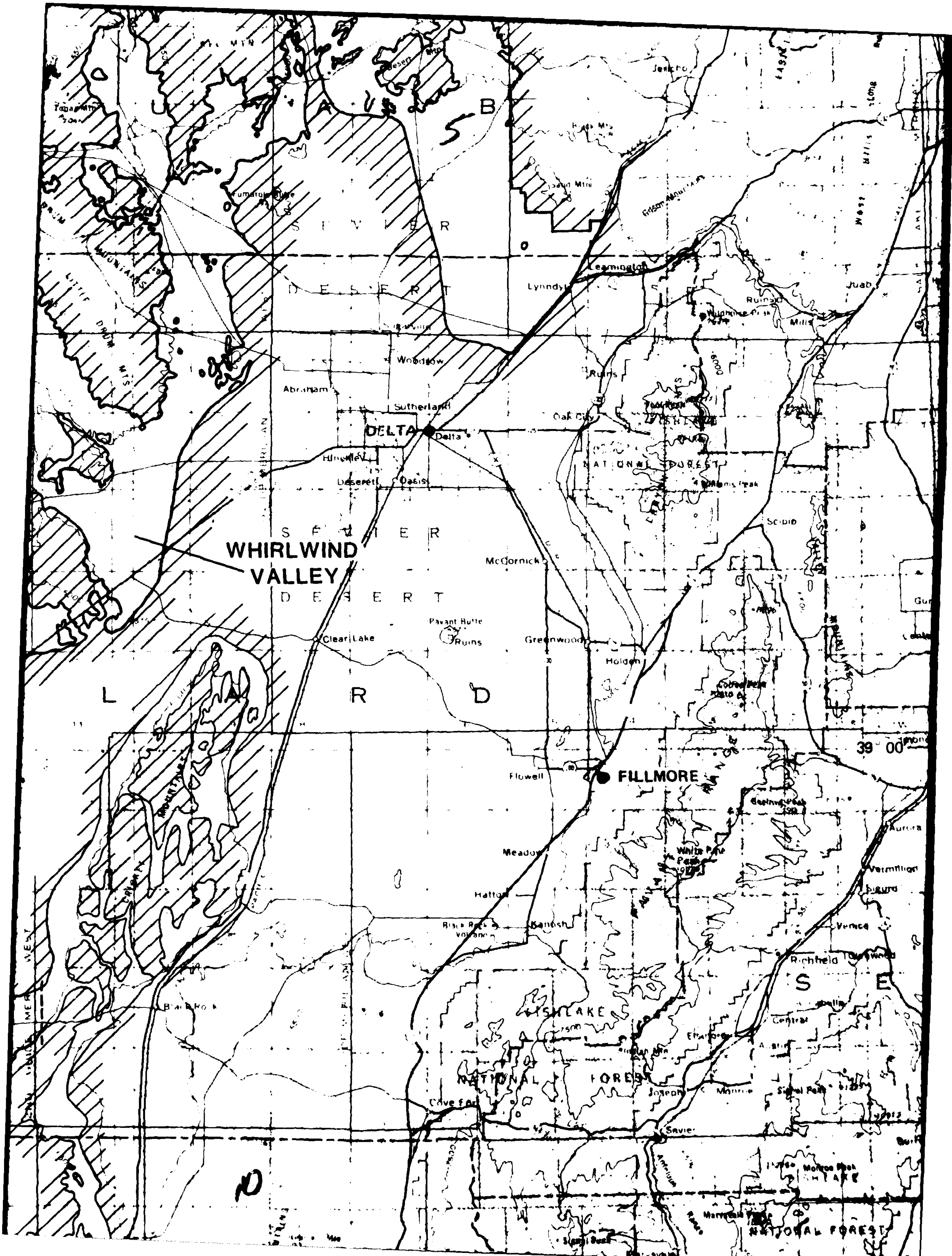

LONG VALLE
EUREKA
ANTELOPE VALLEY
MONITOR VALLEY
NEWARK VALLEY
LITTLE SMOKY VALLEY
BIG SAND SPRINGS VALLEY
HOT CREEK VALLEY
STONE CABIN VALLEY
RAILROAD VALLEY



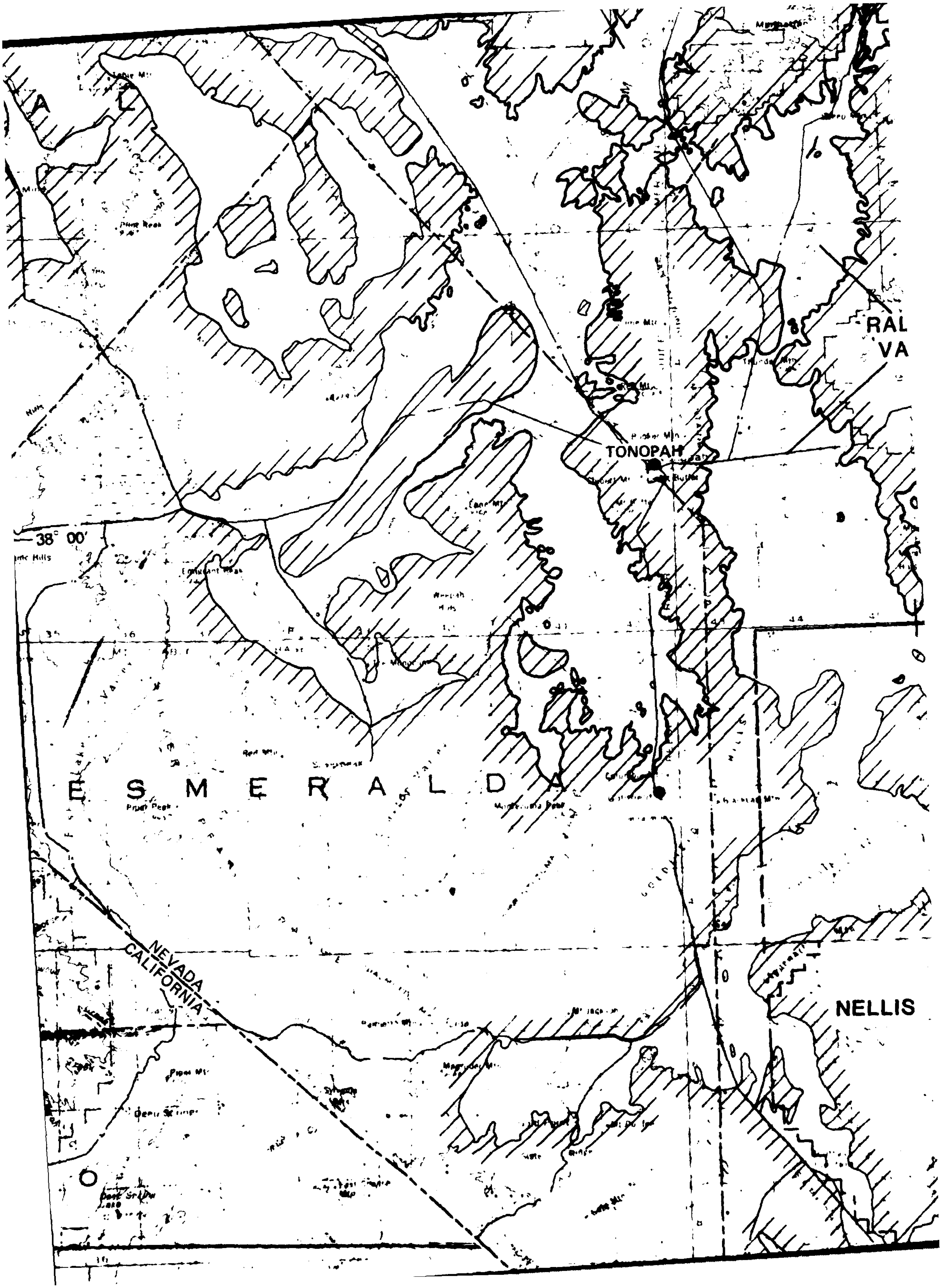
BUTTE VALLEY
JAKES VALLEY
ELY
RAILROAD VALLEY
STEPTOE VALLEY
SPRING VALLEY
HAMLIN VALLEY
CAVE VALLEY
WHITE RIVER VALLEY
HUMBOLDT NATIONAL FOREST



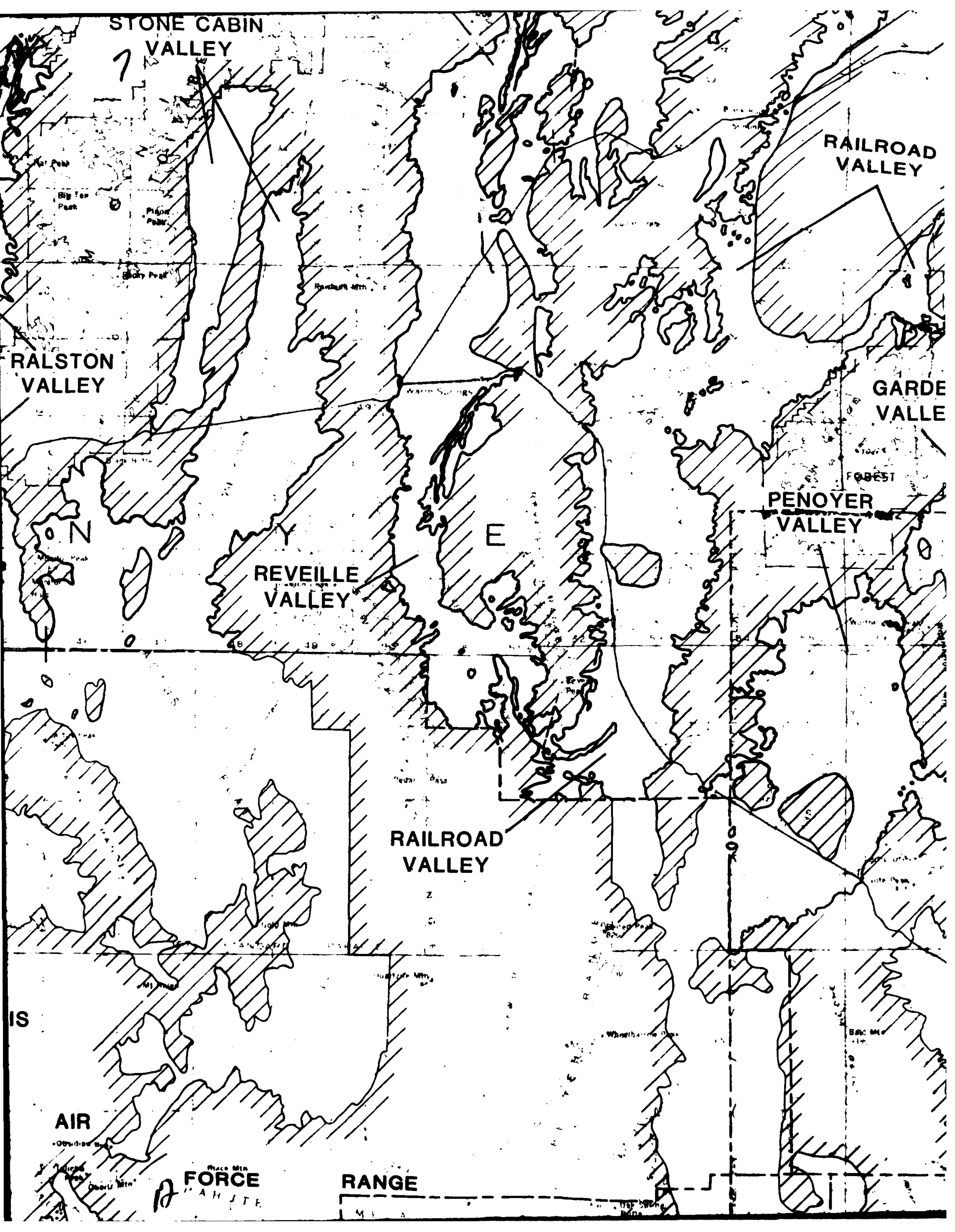
SNAKE VALLEY
TULE VALLEY
SPRING VALLEY
HAMLIN VALLEY
SNAKE VALLEY
PINE VALLEY
HUMBOLDT NATIONAL FOREST
SAWTOOTH MTN
Baker
Garrison
9.

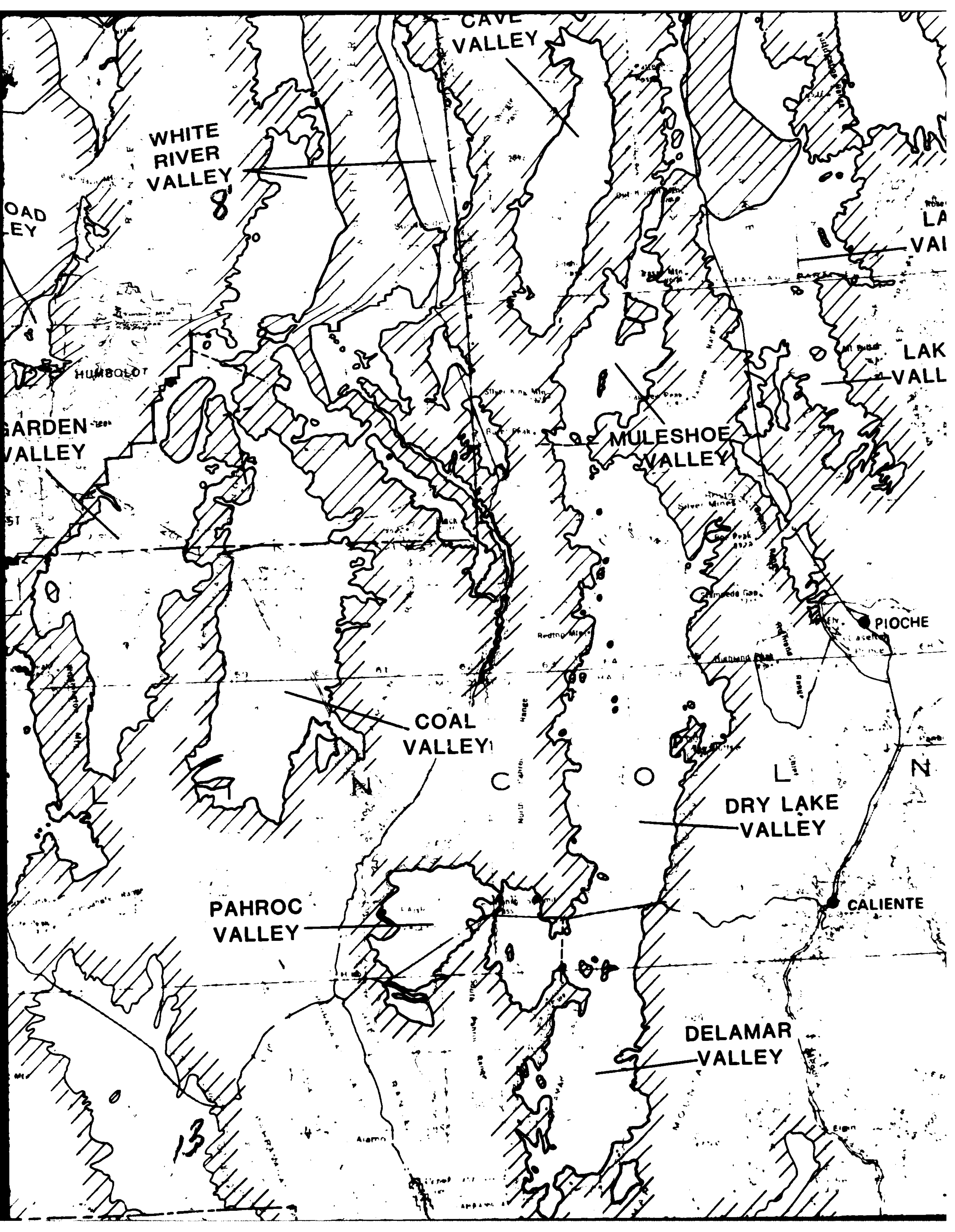


WHIRLWIND VALLEY
DELTA
FILLMORE
SEVIER DESERT
SEVIER DESERT
Jericho
Leamington
Lynndyl
Juab
Woodrow
Abraham
Sutherland
Delta
Hinckley
Deseret
Oasis
Oak City
NATIONAL FOREST
Scipio
McCornick
Pavant Butte
Ruins
Clear Lake
Greenwood
Holden
Flowell
Meadow
Hatton
Kanosh
Richfield
Aurora
Vermillion
Sigurd
Venice
Central
Elsinore
Joseph
Monroe
Cove Fort
Sevier
Black Rock
FISHLAKE
NATIONAL FOREST
39° 00'

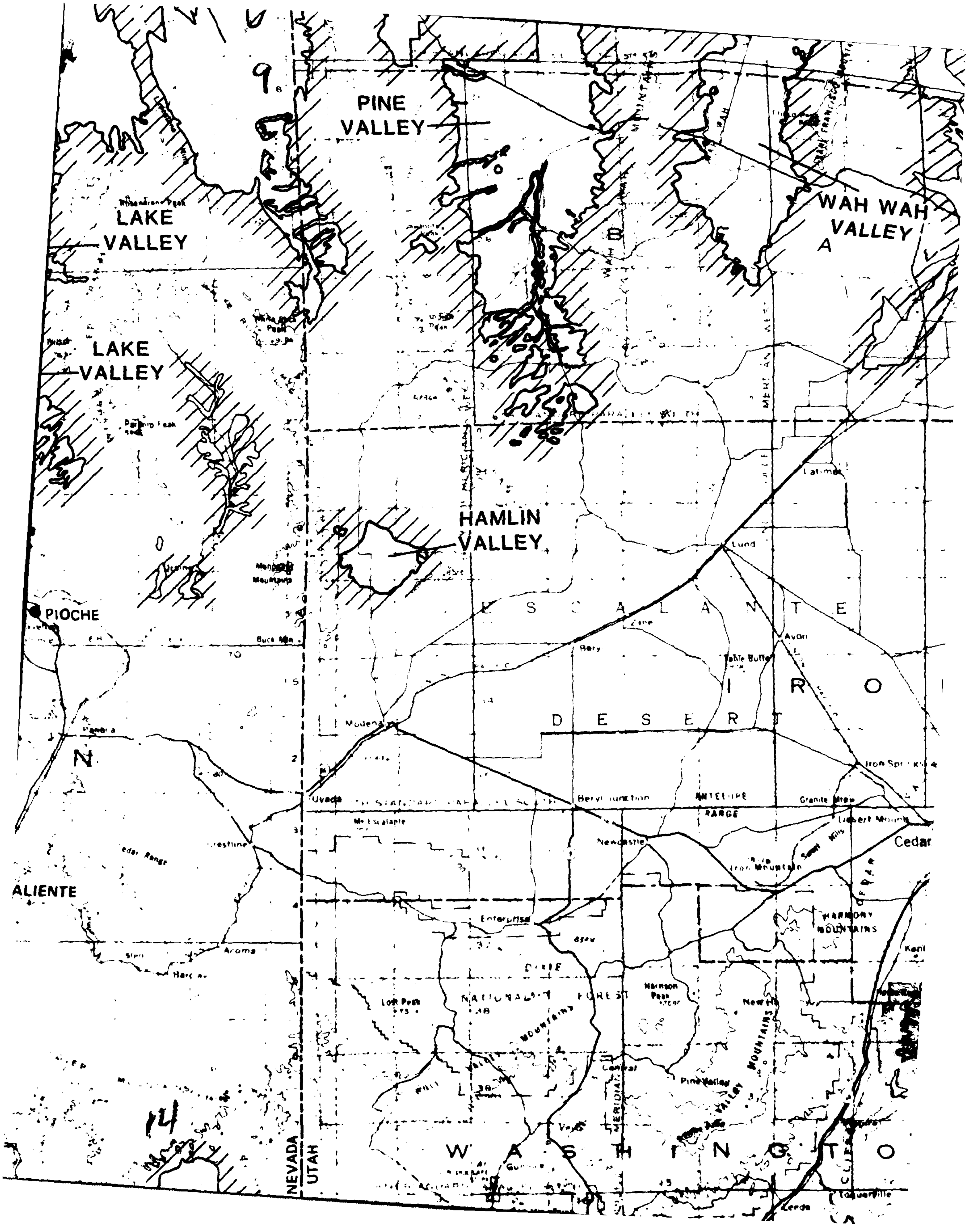


TONOPAH
ESMERALDA
NEVADA
CALIFORNIA
NELLIS
38° 00'
RAL
VA

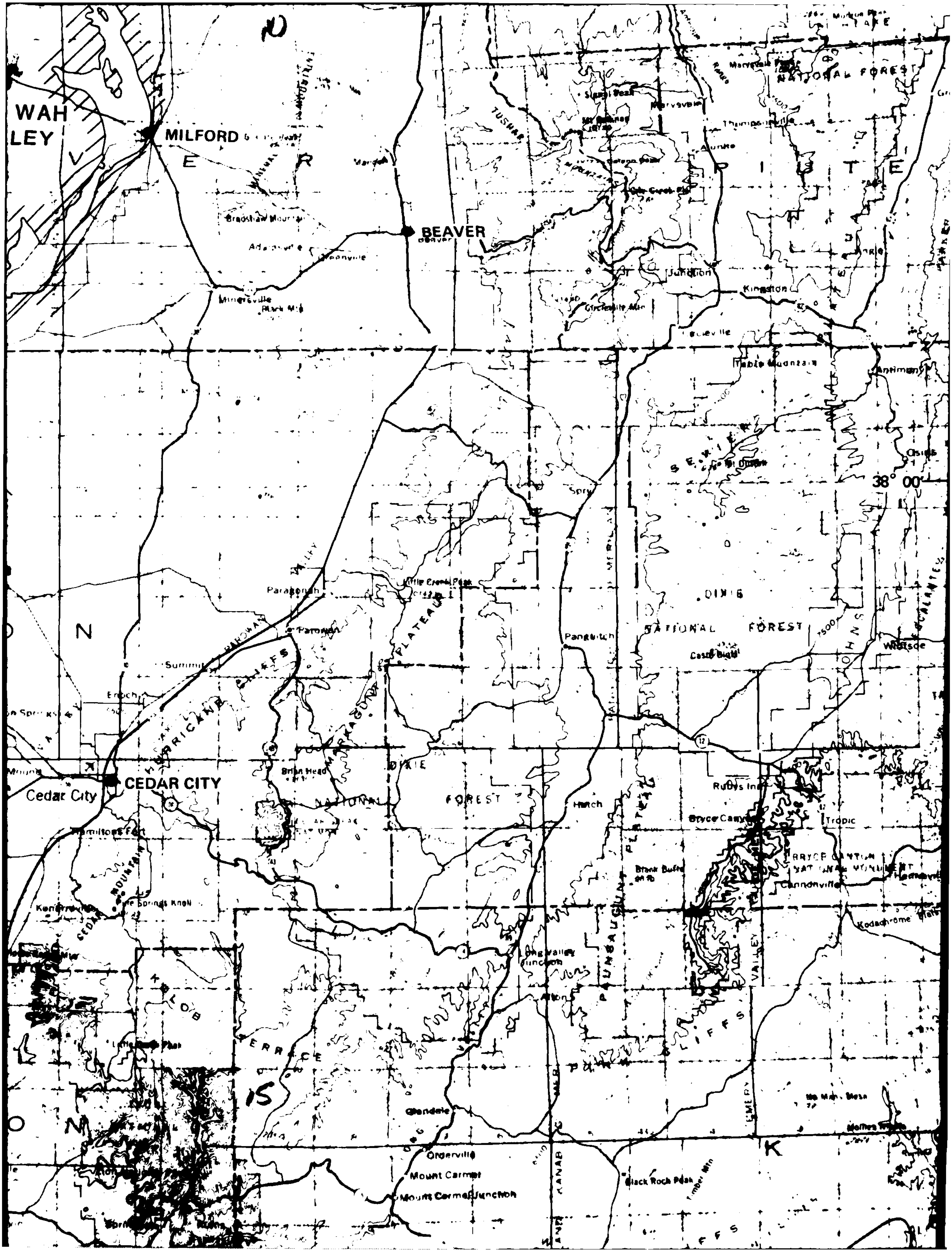

STONE CABIN VALLEY
RAILROAD VALLEY
RALSTON VALLEY
GARDE VALLE
PENOYER VALLEY
N Y E
REVEILLE VALLEY
RAILROAD VALLEY
IS
AIR
FORCE
RANGE



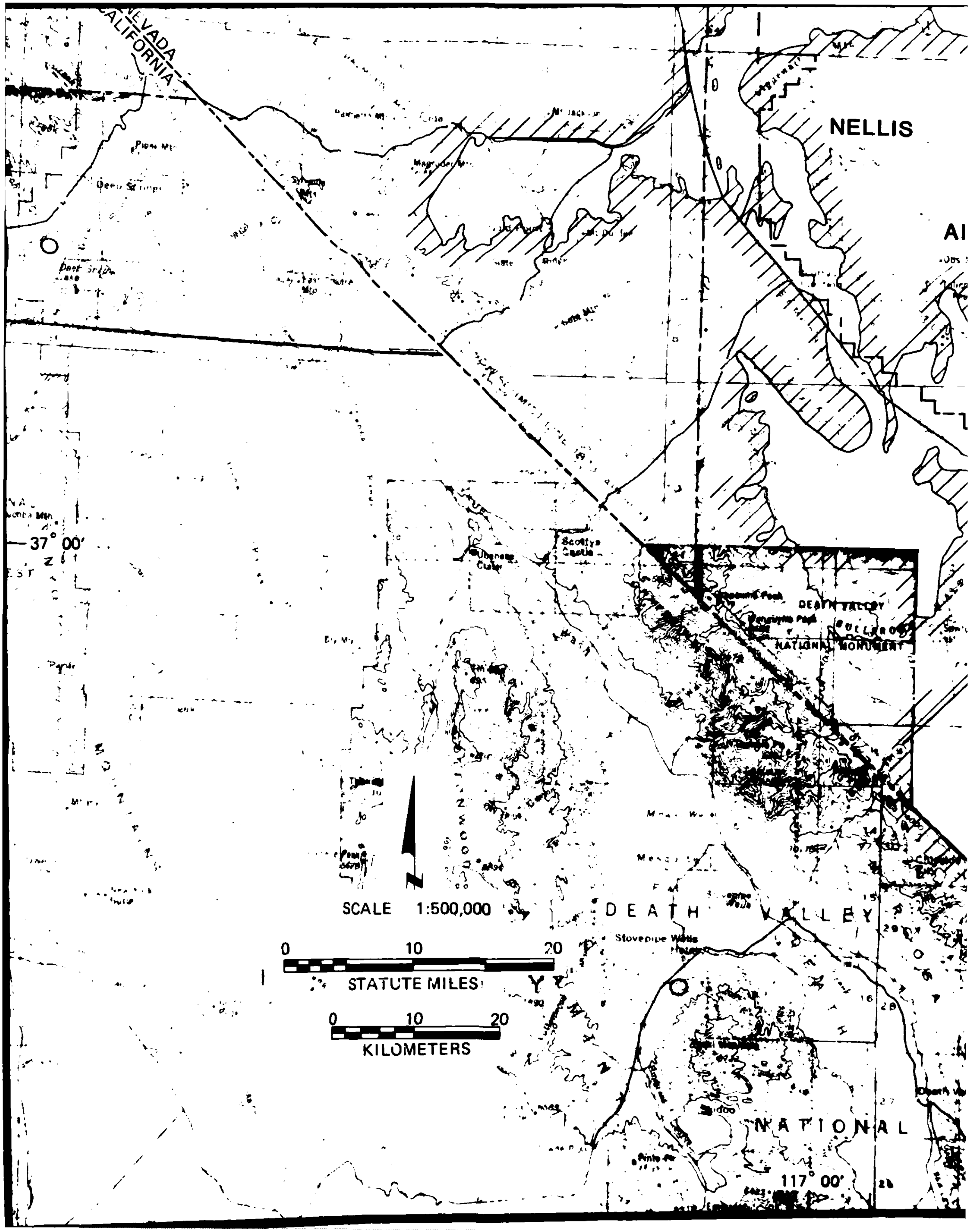
CAVE VALLEY
WHITE RIVER VALLEY
8
HUMBOLDT
GARDEN VALLEY
MULESHOE VALLEY
LAKE VALLEY
PIOCHE
COAL VALLEY
DRY LAKE VALLEY
PAHROC VALLEY
CALIENTE
DELAMAR VALLEY
13



9
PINE VALLEY
LAKE VALLEY
LAKE VALLEY
WAH WAH VALLEY
A
B
HAMLIN VALLEY
PIOCHE
ESCALANTE
IRON
DESERT
N
Modena
Lund
Latimer
Zane
Bery
Avon
Table Butte
Uvada
Beryl Junction
ANTELOPE RANGE
Granite Mtn
Iron Springs
Desert Mound
Cedar
Newcastle
Iron Mountain
Crestline
Cedar Range
ALIENTE
Panaca
Enterprise
Aroma
HARMONY MOUNTAINS
Mt Escalante
Buck Mtn
DIXIE NATIONAL FOREST
PINE VALLEY MOUNTAINS
Pine Valley
Central
Veyo
Gunlock
Toquerville
Leeds
Harmon Peak
Lost Peak
NEVADA
UTAH
WASHINGTO
14



WAH
LEY
MILFORD
BEAVER
Minersville
Bradshaw Mountain
Adamsville
Greenville
Junction
Kingston
Circleville
Marysvale
Thompsonville
Alunite
NATIONAL FOREST
TUSHAR
Table Mountain
Antimony
Osiris
38° 00'
SEVIER
DIXIE
NATIONAL FOREST
Panguitch
Castle Bluff
Widtsoe
Spry
Paragonah
Parowan
Summit
Enoch
Little Creek Peak
HURRICANE CLIFFS
PLATEAU
MARKAGUNT
CEDAR CITY
Cedar City
Hamiltons Fort
Kanarraville
Brian Head
DIXIE
NATIONAL
FOREST
Hatch
Rubys Inn
Bryce Canyon
Tropic
Cannonville
Kodachrome
Long Valley Junction
Alton
PAUNSAUGUNT
KOLOB
TERRACE
Glendale
Orderville
Mount Carmel
Mount Carmel Junction
Black Rock Peak
KANAB
CLIFFS
K
N
15


NEVADA
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NELLIS
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Scottys Castle
DEATH VALLEY
NATIONAL MONUMENT
SCALE 1:500,000
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STATUTE MILES
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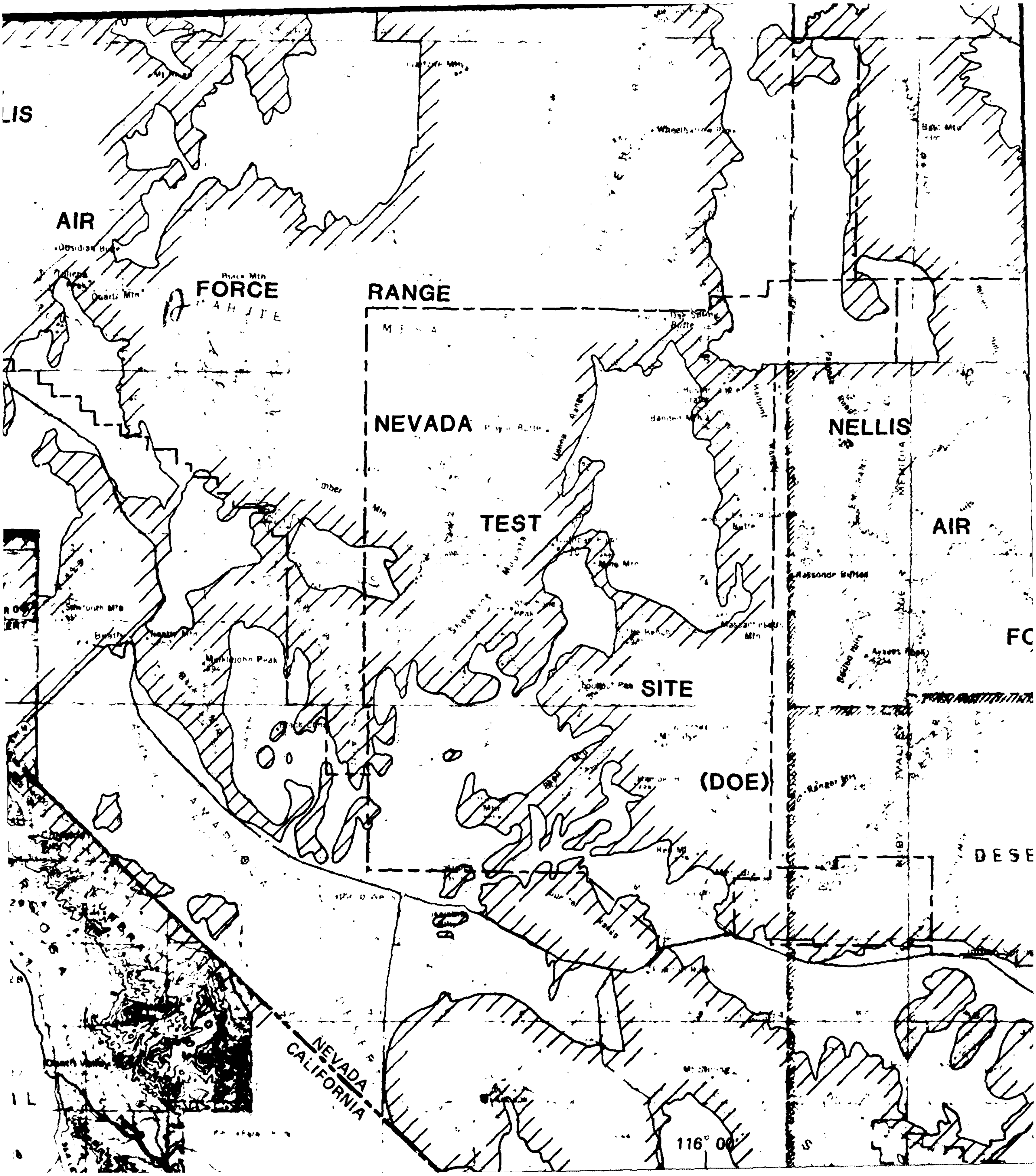
20
KILOMETERS
DEATH VALLEY
Stovepipe Wells Hotel
NATIONAL
117° 00'



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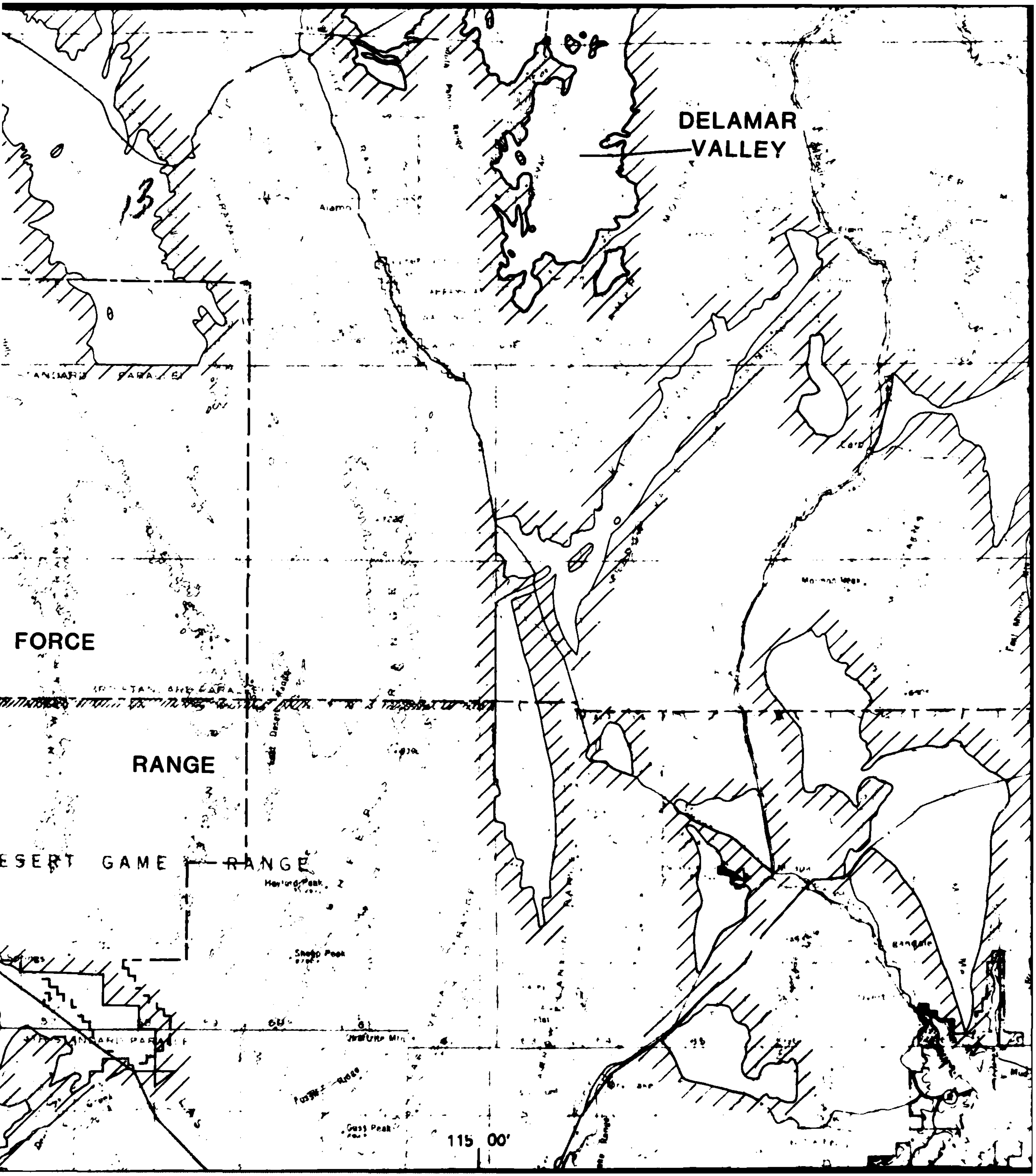

DELAMAR
VALLEY
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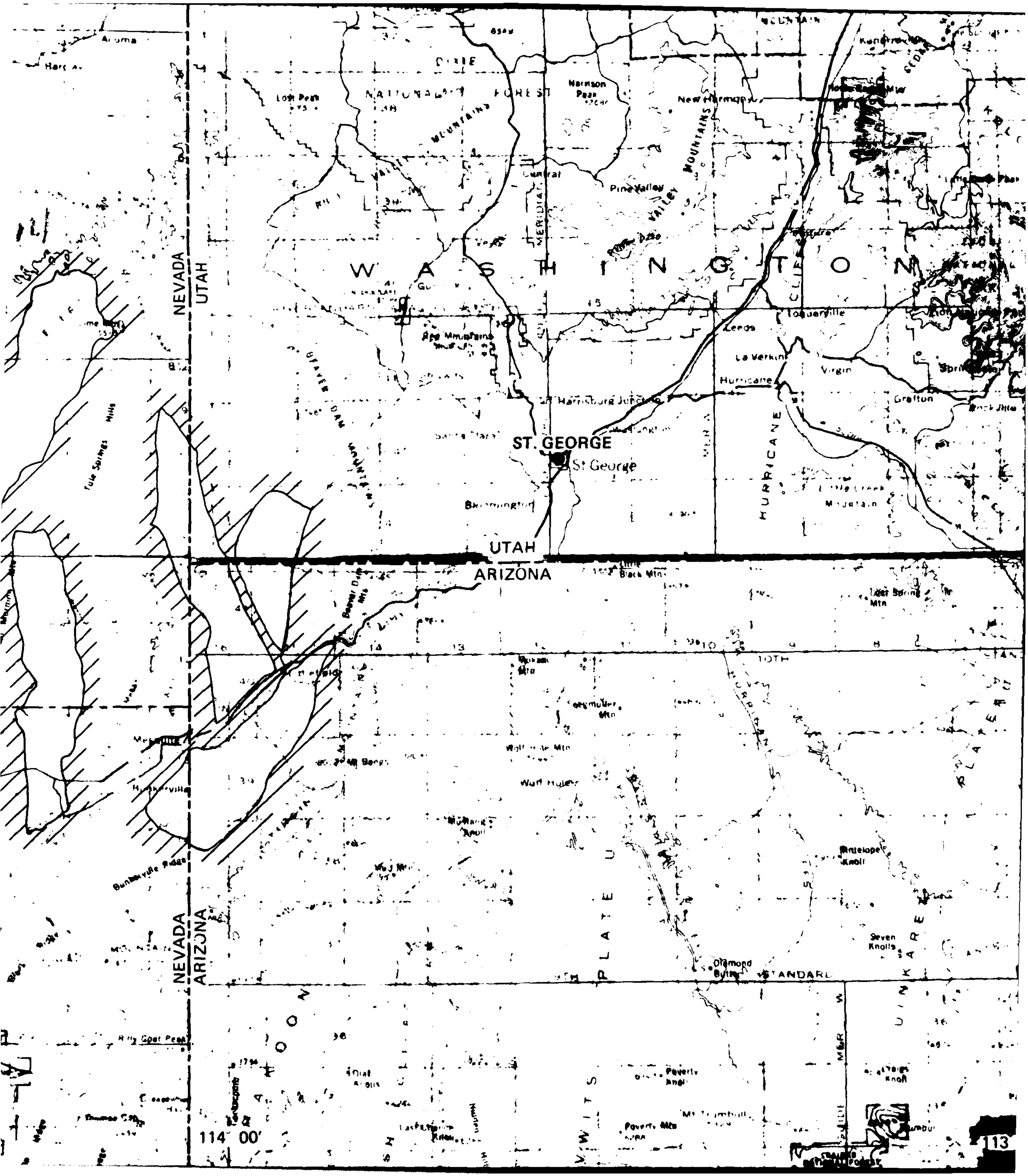
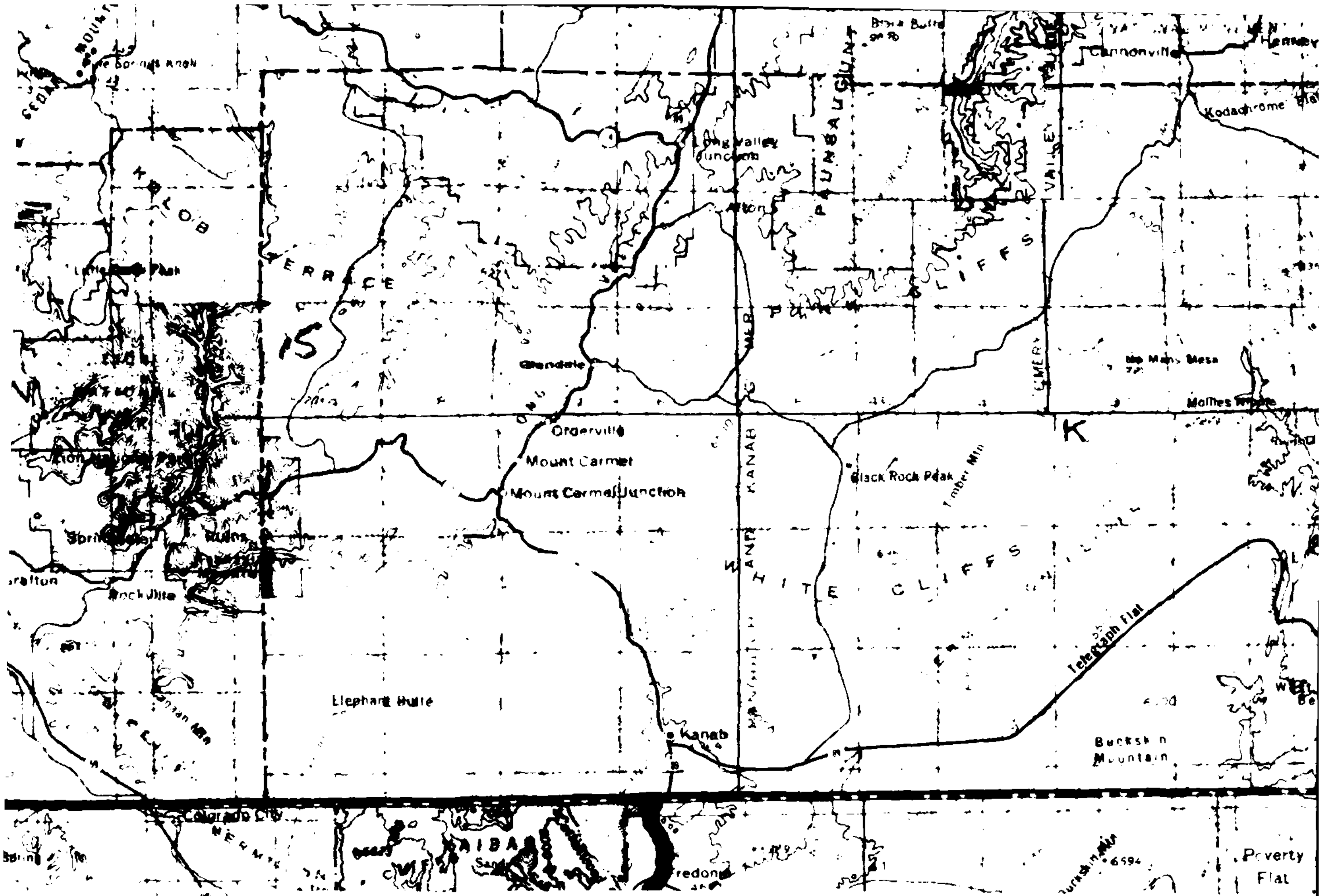


DIXIE
NATIONAL FOREST
PINE VALLEY MOUNTAINS
Pine Valley
Central
New Harmony
W A S H I N G T O N
Toquerville
Leeds
La Verkin
Hurricane
Virgin
Grafton
Harrisburg Junction
ST. GEORGE
St George
Bloomington
HURRICANE
UTAH
ARIZONA
NEVADA
UTAH
NEVADA
ARIZONA
Tule Springs Hills
Beaver Dam Mts
Wolf Hole Mtn
Mt Trumbull
Diamond Butte
Seven Knolls
Antelope Knoll
Poverty Knoll
Poverty Mtn
STANDARD
PLATEAU
Bunkerville Ridge
Mesquite
Littlefield
Billy Goat Peak
114° 00'
113



EXPLANATION

SUITABLE AREA FOR HORIZONTAL SHELTER BASED ON VERIFICATION STUDIES FY 78, FY 79 AND FY 80

SUITABLE AREA FOR HORIZONTAL SHELTER BASED ON SCREENING STUDIES. LOCALLY MODIFIED BY PRIOR VERIFICATION STUDIES

1 25 OCT 1979
2 27 FEB 1980
3 20 JUN 1980
4 26 NOV 1980
5 ________
6 ________
7 ________

113° 00'

GEOTECHNICALLY SUITABLE AREAS NEVADA-UTAH

MX SITING INVESTIGATION

DEPARTMENT OF THE AIR FORCE – BMO

DRAWING 2 - 1

FUGRO NATIONAL, INC.

municipal water-supply and wastewater-treatment facility study for the potentially affected communities in or near the MX siting area in Nevada and Utah. The studies were conducted for Fugro National by the Desert Research Institute (DRI) for Nevada and by the Utah Water Research Laboratory (UWRL) for Utah. Both reports were submitted under separate cover to the AFRCE-MX on 20 June 1980.

The results of a two-phased water legal study and industry activity inventory conducted for Fugro National by DRI and UWRL were also presented to the AFRCE-MX in FY 80. Phase I of the legal study by DRI was presented to the AFRCE-MX in revised form on 2 June 1980 and was titled "Nevada and Utah Water Law and Procedures for Rights Acquisition." Phase II of the legal study, "Water Rights in Nevada and Utah, An Inventory within the MX Area," is in preparation. Both of these studies have been conducted to assist in the water appropriations process. An Industry Activity Inventory was conducted by DRI and UWRL to determine current water use in the siting area and the potential for future development by industry that may conflict with MX. The results of the inventory were submitted to the AFRCE-MX on 2 September 1980.

3.2 SCOPE AND OBJECTIVES

The general approach of the MX Water Resources Program has been to update and expand the existing data base in the Nevada-Utah siting area in order to identify and quantify aquifer characteristics, ground-water and surface water regimes, water quality, and water use and appropriations in the region. A program of

aquifer testing, determinations of local and regional ground-water flow patterns, analyses of water quality characteristics, and computer simulations of the effects of pumping on water levels in wells and on spring discharge has been conducted. This information will provide the basis for achieving the primary program objectives:

- o Determine the effects of MX ground-water withdrawals on local water users, the environment, and the aquifers;
- o Determine the optimum water source and supply system with possible supply alternatives for each valley where MX and attendant facilities are planned; and
- o Provide the necessary data and documentation to support state and federal water regulatory agency requirements for permits and water development.

This information is being obtained through the following activities and studies:

- o Review existing pertinent publications and data contained in agency files relating to water availability, local water use, regional ground-water flow systems, and aquifer characteristics.
- o Contact various state and federal officials knowledgeable about ground-water conditions in Nevada and Utah.
- o Perform hydrogeologic field studies to identify water uses, measure ground-water levels, collect ground-water samples for chemical analyses, measure spring and stream discharges, conduct aquifer tests in existing wells, and overview general hydrogeologic conditions.
- o Drill and test shallow-depth, valley-fill aquifers (<500 feet; <152 m), intermediate-depth, valley-fill aquifers (>500 feet); and carbonate (regional) aquifers. The drilling and testing programs are designed to gather information about aquifer characteristics and regional ground-water flow systems where little or no data exist.
- o Evaluate regional and basin structures to better understand the geologic controls on the regional ground-water flow systems.

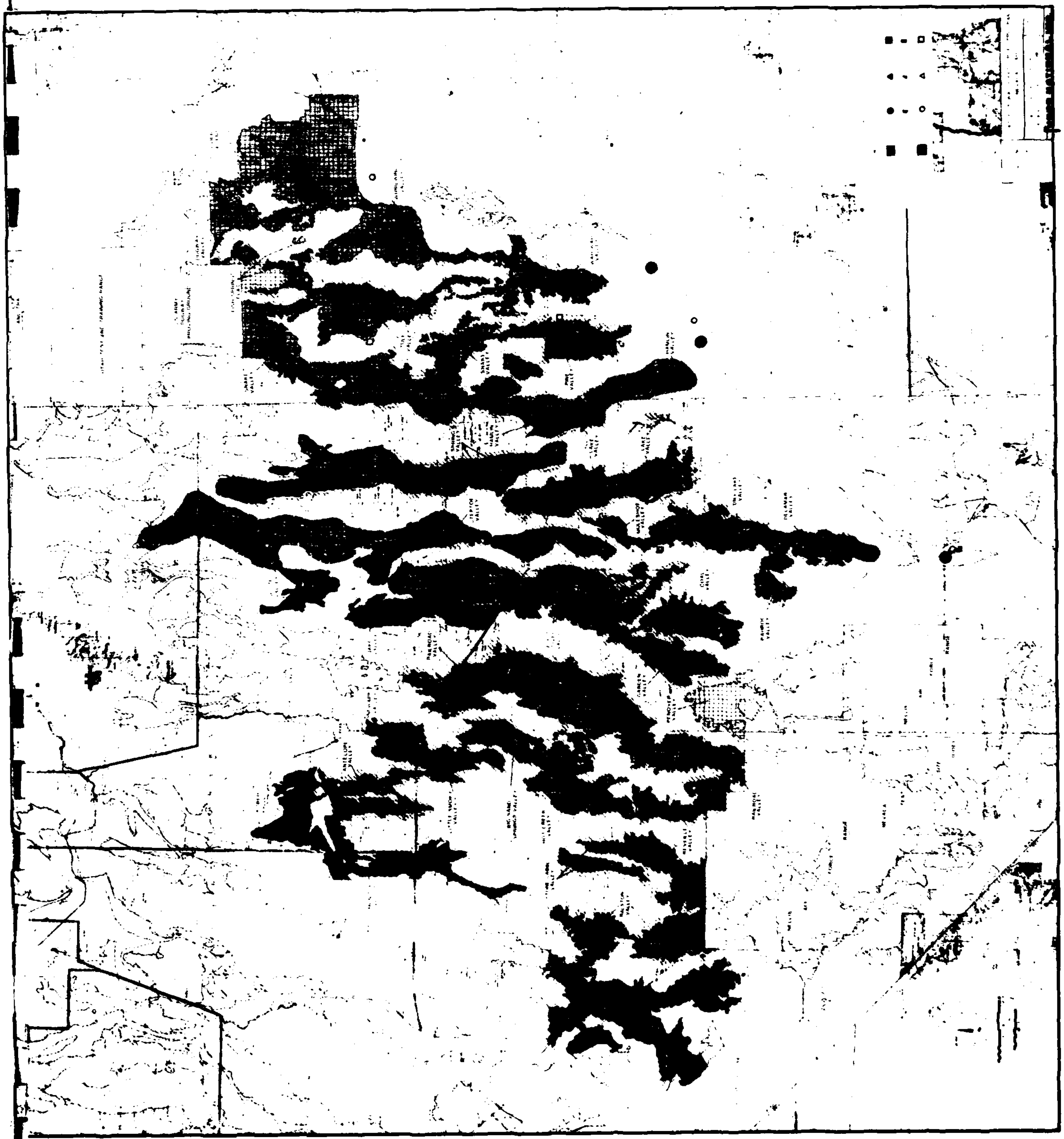
- o Develop computer numerical models of the ground-water system in selected valleys for effects on the local water users and the environment.
- o Investigate surface-water regimes to provide data on the availability of surface water and the rates and quantities of potential recharge to the ground-water systems.
- o Assess the relationship between evapotranspiration and depth to ground water in selected valleys to determine the quantity of water consumed by phreatophytes.
- o Assess municipal water-supply and waste-water treatment facilities for their capacity to handle increased demand and loads due to MX population influx. This study includes towns within and immediately adjacent to the siting area with emphasis on Tonopah, Ely, Caliente, and Pioche in Nevada and Delta, Milford, and Cedar City in Utah.
- o Review and study Nevada and Utah water laws and permitting procedures and conduct a water rights inventory. This study will aid in the filing of water appropriation applications.
- o Make an industry activity inventory to identify the water requirements of existing and proposed industries in the siting area and determine how these requirements may interact with MX construction and operational activities.
- o Assess the quantity of water required by MX activities in each valley and submit an application for appropriation of water. Define points of diversion for ground-water withdrawal and survey diversion sites.

Figure 3-1 shows the valleys investigated and the locations of drilling/testing operations, and Table 3-1 lists the number of field activities conducted to date.

3.3 WATER RESOURCES DATA COLLECTION STUDIES

3.3.1 Valley-Fill Aquifer

The valley-fill aquifer studies have included hydrologic reconnaissances as well as shallow- and intermediate-depth drilling programs. The hydrologic reconnaissances have been completed for 29 valleys including the six valleys studied in FY 79. As



STATUS OF WATER RESOURCES PROGRAM
NEVADA-UTAH
FIGURE 3-1

VALLEY	DRILLED WELLS	PUMP TESTS	WATER QUALITY ANALYSES	WATER LEVEL MEASURE-MENTS	DISCHARGE MEASURE-MENTS	WATER TABLE MONITORING WELL
ANTELOPE	0	1	4	15	9	0
BIG SAND SPRINGS	0	1	1	2	4	0
BIG SMOKY	0	2	5	23	2	0
CAVE	2	3	4	8	3	1
COAL	3	2	1	6	1	10
DELAMAR/ DRY LAKE	4	2	4	6	3	0
DUGWAY	3	2	1	3	1	4
FISH SPRINGS FLAT	0	1	2	10	1	9
GARDEN	2	1	10	18	9	0
HOT CREEK	4	2				
LAKE	0	0	0	7	0	8
LITTLE SMOKY	0	1	4	17	4	0
MULESHOE	0	0	3	1	8	0
PAHROC	0	0	1	5	1	0
PENOYER	0	0	5	7	9	0
PINE	2	1	5	1	1	0
RAILROAD	4	3	7	6	11	0
RALSTON	0					
REVEILLE	0	1				
SEVIER DESERT	0	1	8	18	0	8
SNAKE/ HAMLIN	2	10	48	54	36	45
SPRING	2	2	15	29	14	9
STONE CABIN	0					
TULE	4	3	8	17	5	11
WAH WAH	3	1	1	0	0	0
WHIRLWIND	2	2	2	9	2	12
WHITE RIVER	1	7	20	55	3	5

SUMMARY OF WATER RESOURCES PROGRAM ACTIVITIES

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE — BMO

TABLE 3-1

FUGRO NATIONAL, INC.

of 30 September 1980, valley-fill drilling and testing has been completed for ten valleys: Dugway, Tule, Hamlin, Spring, Railroad, Hot Creek, Pine, Dry Lake, Delamar, and White River and is in progress in four valleys: Wah Wah, Whirlwind, Garden, and Cave. Specifics of the drilling operations and aquifer test results are summarized in Table 3-2.

3.3.1.1 Results and Conclusions

Although reduction and evaluation of data collected in FY 80 is still in progress, preliminary results and conclusions of the valley reconnaissance and drilling operations can be summarized as follows:

- Most valleys in the siting area appear to have sufficient ground water available for MX construction needs based on state perennial yield estimates, ground water in storage, and present water-use data.

- The ground water is generally potable, but of fair to poor quality witn local occurrences of water that is very poor or unsuitable for drinking.

- Well yields during valley-fill aquifer testing (reconnaissance and drilling programs) have ranged from 75 gallons per minute (gpm) (4.7 liters per second; l/s) to 2200 gpm (139 l/s) depending on the valley or portion of the valley tested. Well yields averaged 420 gpm (26.5 l/s) for the test wells.

- Low well yields (less than 100 gpm or 161 acre-feet per year; acre-ft/yr) (<6.31 l/s or 0.2 cubic hectometers per year; hm^3/yr) occurred in southern Tule, northern Pine, and Delamar valleys.

- Moderate well yields ranging from 100 to 345 gpm (6.3 to 21.8 l/s) or 161 to 556 acre-ft/yr (0.2 to 0.7 hm^3/yr) occurred in northern Tule, southern Hamlin, and Wah Wah valleys.

- High well yields (greater than 500 gpm [31.6 l/s] or 806 acre-ft/yr [1 hm^3/yr]) occurred in Dry Lake, Spring, Railroad, White River, Snake, northern Little Smoky, northern Hamlin, Steptoe, Penoyer, and Big Smoky valleys.

VALLEY (LOCATION)	DRILLING RESULTS								
	TEST WELL				OBSERVATION WELL			DEPTH TO WATER (FEET)	C
	DEPTH (FEET)	CASING DIA-METER (INCHES)	DRILLING DATES START	DRILLING DATES END	DEPTH (FEET)	DRILLING DATES START	DRILLING DATES END		
Dugway 1 12S/10W 31cc	402	10	7/28/80	8/3/80	None			Dry	
Dugway 2 11S/10W 19bb	None	None	7/28/80	8/2/80	178	7/28/80	7/31/80	Dry	
Spring 9N/68E 30ab	710	10	8/3/80	8/7/80	710	8/9/80	8/11/80	231***	
Hamlin 8N/69E 30ab 35dc	480	10	8/18/80	8/24/80	522	8/6/80	8/7/80	158***	
Railroad 1 3N/52E 2dd	484	10	8/1/80	8/10/80	495	8/14/80	8/15/80	233***	
Hot Creek 1 7N/51E 10aa	540	10 & 8	8/26/80	8/29/80	500	9/2/80	9/8/80	237***	
Coal/Garden 3N/59E 10	1530 to Present		8/17/80						
Steptoe 12N/63E 12ba	2450		8/80						

DATE As of September 30, 1980

*PRELIMINARY DATA

***Measurement made on the same day of the aquifer test

APPROVED BY ____ CHECKED BY ____ DRAWN BY ____ COMPILED BY ____

WELL	AQUIFER TEST RESULTS*					COMMENTS
G DATES	DEPTH TO WATER (FEET)	DISCHARGE (GPM)	TRANSMISSIVITY (GPD/FT)	TESTING DATES		
END				START	END	
	Dry	None		None	None	
7/31/80	Dry	None		None	None	
8/11/80	231***	600	430,000	8/15/80	8/30/80	
8/7/80	158***	155	12,100	9/9/80	8/14/80	
8/15/80	233***	700	70,000	8/12/80	9/29/80	
9/8/80	237***	300	86,000	9/26/80	10/9/80	
						Drill pipe stuck in hole. A new ole is being drilled.

2

DRILLING AND TESTING INFORMATION

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE – BMO

TABLE 3
PAGE 1 OF 2

FUGRO NATIONAL, INC.

VALLEY (LOCATION)	DRILLING RESULTS								A(
	TEST WELL				OBSERVATION WELL			DEPTH TO WATER (FEET)	CH (
	DEPTH (FEET)	CASING DIA-METER (INCHES)	DRILLING DATES		DEPTH (FEET)	DRILLING DATES			
			START	END		START	END		
Hot Creek 2 6N/50E 27ac	505	10	8/27/80	8/30/80	455	9/6/80	9/7/80	291***	
Railroad 2 10N/58E 17bd	600	10	9/15/80	9/29/80	600			281***	
Pine 26S/17W 10aa	951	10	7/8/80	7/12/80	1157	6/8/80	7/10/80	443***	
Cave 7N/63E 14ab	462	10	9/11/80	9/25/80	458	8/23/80	9/10/80	230***	
Wah Wah 26S/14W 25ab					1251	7/7/80	7/30/80	Dry	
Garden 2N/57E 15bd	1065	10	9/11/80	10/24/80	1099	8/7/80	8/16/80	421***	
Whirlwind 15S/12W 19ad			10/20/80		1220	9/15/80			
Wah Wah 27S/14W 28dd	In Progress		10/23/80		1399	7/27/80			
White River 8N/61E 27dc					1300	11/20/80	12/19/79	42**	1
Dry Lake 35/64E 12ca	1012	10	1/26/80	2/12/80	1305	1/3/80	1/24/80	396***	
Delamar 65/63E 12a	1215	10	2/29/80	3/12/80	1012	2/15/80	2/23/80	871***	
Tule 1 20S/14W 6dd	624	10	7/8/80	7/15/80	624	7/20/80	7/21/80	90***	
Tule 2 17S/15W 17ca	409	10	7/8/80	7/16/80	311	7/21/80	7/22/80	47***	

DATE As of September 30, 1980

*PRELIMINARY DATA

**Measurement Made on January 1980

***Measurement made on the same day of the aquifer test

APPROVED BY ___ CHECKED BY ___ DRAWN BY ___ COMPILED BY ___

WELL ... DATES END	DEPTH TO WATER (FEET)	DIS-CHARGE (GPM)	TRANS-MISSIVITY (GPD/FT)	TESTING DATES START	TESTING DATES END	COMMENTS
	AQUIFER TEST RESULTS*					
9/7/80	291***	375	13,200	9/24/80	10/3/80	
	281***	700		10/19/80		
7/10/80	443***	--	2,500	7/20/80	8/10/80	
9/10/80	230***	223	11,100			
7/30/80	Dry	None				Hole dry. New Site selected in Wah Wah Valley
8/16/80	421***	400*				
12/19/79	42**	None		None	None	This well was originally drilled as a test well but converted to an observation well. A test well is in process of being drilled.
1/24/80	396***	500	45,000	4/3/80	4/27/80	
2/23/80	871***	85	5,000	5/3/80	5/13/80	
7/21/80	90***	75	5,100	7/28/80	8/15/80	
7/22/80	47***	345	50,000	8/1/80	8/15/80	

2

DRILLING AND TESTING INFORMATION

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE – BMO

TABLE 3.2
PAGE 2 OF 2

FUGRO NATIONAL, INC.

- Two wells drilled in Dugway Valley penetrated rock at about 360 feet (110 m) and 155 feet (47 m), respectively, and no ground water was detected in the wells. Development of a valley-fill aquifer as a source of construction water supply in Dugway Valley will require additional exploration and may prove not to be feasible. A possible carbonate (deep) aquifer may have to be developed or water may have to be imported.

- Drawdown of water levels in existing wells or springs and alteration of spring discharge has not been detected during aquifer testing by pumping the test wells.

- Most springs in the siting area are from meteoric sources (precipitation and snowmelt), perched aquifers, or the regional carbonate aquifer and do not appear to be directly connected to the main valley-fill aquifer. Thus, the potential for MX ground-water withdrawals from the valley-fill aquifers to affect the springs which may harbor endangered species is greatly diminished.

3.3.2 Carbonate Aquifer

Carbonate (regional) aquifer drilling activities were initiated in July 1980 to evaluate the regional ground-water flow systems which may hydrologically connect many of the valleys in the siting area. One well was completed in Steptoe Valley to a depth of 2447 feet (746 m) below ground surface and two other wells were in progress in Coal Valley and Dry Lake Valley at the close of FY 80. Testing of the carbonate aquifer had not yet begun, so water quality information and aquifer characteristics are not yet available. However, cavernous carbonate rock capable of transmitting significant quantities of water was penetrated and it appears that carbonate (regional) aquifers could serve as an alternate source of water to the development of valley-fill aquifers in some areas. The potential effects of such development on environmentally sensitive areas (springs and

seeps) is undetermined pending completion of the water resources program.

3.4 WATER LEGAL STUDIES

3.4.1 Overview of Nevada and Utah Water Laws

In both Nevada and Utah, the basic water law is the doctrine of prior appropriation for beneficial use.

In Nevada, the requirements that must be satisfied for the appropriation of ground water are 1) unappropriated water is available, 2) a recognized beneficial use is established, and 3) no interference with existing rights is demonstrated. The state engineer can be expected to take into consideration lowering of water levels at nearby wells in determining availability while considering the average annual replenishment rate.

In Utah, the state engineer can approve an application for appropriation if 1) there is unappropriated water available, 2) the proposed use will not impair existing rights or interfere with a more beneficial use of the water, 3) the proposed use is physically and economically feasible, 4) the applicant has the ability to complete the plan and, 5) the application is filed in good faith and not for the purpose of speculation.

Statute law in both states gives the state engineer discretion in approving applications. Decisions of the state engineer is subject to appeal and review by the state court system and ultimately to the state supreme court, in which case could take up to two years to be approved.

3.4.2 Process for Obtaining Permits to Appropriate Water

Permits to appropriate water in Nevada and Utah require information on the applicant and on the source of water. Required information includes name and address of applicant, source and amount of water, location and cost of works, purpose, and time frame for construction and use. Hydrologic information is not required but may be needed if a protest is filed.

In both states, the process for appropriating water is quite similar. The applicant must first file an application to appropriate, after which the state engineer publishes a notice in the local newspapers (published five consecutive weeks in Nevada and three weeks in Utah). After the date of the last publication, interested parties have 30 days, in both states, in which to file a protest. The state engineer may then approve or disapprove the application based on availability of water and the merit of the protests. This usually takes about 30 days in both states.

3.4.3 Water Rights Inventory

The water rights inventory conducted for Fugro National by DRI included the compilation of existing water rights according to their legal status, water source, ownership class, and type of water use for 44 hydrographic basins in Nevada and 14 hydrographic basins in Utah. The results of the study indicate that the total amount of ground-water rights in all stages of application and appropriation exceeds the perennial yield in most basins. The majority of these rights are in the Permits and

Applications phase; certificates and proofs generally represent less than the perennial ground-water yield in each basin. Definition of various terms used in appropriations activities are as follows:

- An Application: May be pending further action, approved, rejected, under protest, rejected and under appeal, etc.;
- A Permit: Allows the party to proceed with an approved application under conditions prescribed by the approval;
- A Proof: Claims historical beneficial use or vested rights (Diligence Claim in Utah); and
- A Certificate: Establishes the legal status of "water right."

It is very unlikely that all applications and permits will proceed to the certificate stage. In Nevada, for example, about half of the applications that have been filed since filing procedures began in 1905 have been filed within the last four or five years in conjunction with applications under the Carey and Desert Land Entry Acts. As such, they are being held in a "Ready-for-Action" status by the Nevada State Engineer pending release of those lands from the public domain.

Surface water in the siting area is nearly totally allocated and utilized. Ground water from valley-fill aquifers will be the primary source of water for construction and operation of the MX system.

In general, quantities of unappropriated ground water are available in basins not "designated" by the state engineer in Nevada or "closed" to further appropriation by the Utah State

Engineer. Basins are "designated" by the Nevada State Engineer when the amount of ground-water appropriated nears or exceeds the perennial yield. Such basins are: Big Smoky, Ralston, Stone Cabin, Reveille, Steptoe, Penoyer, and Lake valleys. In these valleys, further appropriations will be considered by the state engineer based on duration, amount, and type of use. In basins "closed" by the Utah State Engineer, further appropriation of ground water will generally not be allowed. Such is the case for the Sevier Desert area. In these designated or closed basins, existing water rights could be leased or purchased, water imported from neighboring valleys where it is more plentiful, or possible carbonate aquifers developed.

3.5 WATER APPROPRIATIONS

Fugro National filed applications for appropriation of ground water in 29 valleys within the Nevada-Utah siting area in FY 80. Table 3-3 lists the valleys for which water appropriation applications have been filed, the quantity of ground water requested, and other details of the filing.

The total quantity of ground water by valley, listed in Table 3-3, is based on number of MX clusters sited in a valley as determined from Fugro National MX shelter layouts. The table also lists the points of diversion for each valley. The total annual quantity of ground water requested in Snake Valley is higher than other valleys due to Nevada and Utah limitations on the transfer of water rights from one state to the other even though it is within the same hydrologic basin.

VALLEY	TOTAL QUANTITY OF GROUND WATER REQUESTED (ACRE - FT/YR)	NUMBER OF POINTS OF DIVERSION	DATE OF FILING
DRY LAKE	3810	1	1-30-80
DELAMAR*	1585	1	1-30-80
WHITE RIVER	3810	1	1-30-80
SNAKE**	5005	4	10-25-79 & 7-15-80
REVEILLE	2770	5	7-11-80
HOT CREEK	3115	5	7-11-80
LITTLE SMOKY	2076	3	7-11-80
ANTELOPE	3805	5	7-11-80
RAILROAD	4148	4	7-11-80
GARDEN	3456	8	7-11-80
COAL	3456	9	7-11-80
PAHROC	1388	4	7-11-80
MULESHOE	1731	3	7-11-80
CAVE	2076	6	7-11-80
SPRING	2425	5	7-11-80
HAMLIN	4146	6	7-11-80
PINE	2421	5	7-11-80
TULE	4146	8	7-11-80
FISH SPRINGS FLAT	2076	7	7-11-80
WAH WAH	3801	7	7-11-80
WHIRLWIND	4146	9	7-11-80
DUGWAY	3111	5	7-11-80
SEVIER	2076	3	7-11-80
STONE CABIN	4152	8	7-15-80
RALSTON	4152	8	7-15-80
BIG SAND SPRING	2076	4	7-15-80
PENOYER	2422	2	7-15-80
LAKE	3805	5	7-15-80
BIG SMOKY	4146	3	7-15-80

*GROUND WATER FOR CONSTRUCTION CAMP AND PLANT NOT REQUESTED DUE TO VERY LOW AQUIFER YIELD

**APPLICATIONS FOR GROUND-WATER APPROPRIATION FILED ON TWO DATES; 1905 (ACRE - FT/YR) FILED ON 10-25-79 AND 3100 (ACRE - FT/YR) FILED ON 7 - 15 - 80

GROUND-WATER APPROPRIATION APPLICATION INFORMATION

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

TABLE 3-3

FUGRO NATIONAL, INC.

The total quantity of ground water per year requested for construction in each valley includes water for a construction plant and camp in each valley except Delamar Valley. In Delamar Valley, the aquifer has a very low yield as indicated by test results.

3.6 MUNICIPAL WATER SUPPLY STUDY

The present capacity of municipal water-supply systems and wastewater-treatment systems and their capacity to expand were investigated for Fugro National by DRI in Nevada and UWRL in Utah. The conclusions of these studies are that significant capital expenditures will have to be made to accommodate water-supply and wastewater-treatment requirements of MX-related population growth. Many of the water-supply and wastewater-treatment systems do not now meet legal requirements. The wastewater systems can be improved and expanded if funding can be obtained. The water-supply systems are expandable given proper funding, but in some cases, water rights are not available for appropriation and will have to be purchased from existing water users.

3.7 INDUSTRY WATER INVENTORY

An inventory of current water users in the area, along with an assessment of possible future demands by industry within or adjacent to the Nevada-Utah siting area, was initiated in the fall of 1979. The study was conducted for Fugro National by DRI in Nevada and UWRL in Utah.

Water demands by the following water-use categories were evaluated:

1. Irrigation of cropland;
2. Livestock watering;
3. Mining and Energy - including mining, milling, power generation, and oil extraction; and
4. Urban/Industrial - including all industrial and commercial activities in urban areas.

Table 3-4 lists the current annual water use in each of the 29 valleys investigated by the end of FY 80 and provides the estimated annual ground-water availability. It is assumed that the water available could be used for MX. Water availability is defined as the perennial yield less current usage and does not take into consideration pending appropriation applications or appropriated water supplies which are not currently being utilized. Approximately 90 percent of the current water use in the siting area is for irrigated agriculture, seven percent is for mining- and energy-related industry, and three percent is for remaining uses.

Based on the estimated construction-water requirements of the MX project, current ground-water withdrawals, and on the estimated perennial yield, it is likely that ground-water withdrawals may exceed the perennial yield in only a few of the nondesignated or nonclosed valleys in the siting area. These valleys are Big Sand Springs and Dry Lake/Muleshoe. In other valleys, the water may not be available for appropriation because the valley is either designated or closed. Eight such valleys exist in the

VALLEY	PERENNIAL YIELD (ACRE - FT/YR)	CURRENT ANNUAL GROUND-WATER USE (ACRE - FT/YR)	ESTIMATED ANNUAL GROUND-WATER AVAILABILITY (ACRE - FT/YR)
ANTELOPE	4,000	437	3,563
BIG SAND SPRINGS	1,000	0	1,000
BIG SMOKY[1]	9,000	33,927[5]	−24,927
CAVE	2,000	0	2,000
COAL	6,000	0	6,000
DELAMAR	3,000	7	2,993
DRY LAKE[2]	3,000	0	3,000
DUGWAY	5,000 to 25,000	3,286	1,714 to 21,714
FISH SPRINGS FLAT	25,000 to 50,000	393	24,607 to 49,607
GARDEN	6,000	91	5,909
HOT CREEK	6,000	297	5,703
LAKE[3]	17,000	14,166	2,834
LITTLE SMOKY	5,000	0	5,000
PAHROC[4]	unknown	minor	—
PENOYER	5,000	5,691	-691
PINE	< 5,000	18	< 4,982
RAILROAD	75,000	4,206	70,794
RALSTON	6,000	1,005	4,995
REVEILLE	unknown	minor	—
SEVIER DESERT	23,500	49,263	−25,763
SNAKE/HAMLIN	80,000	16,598	63,402
SPRING	75,000	4,828	70,172
STONE CABIN	2,000	970	1,030
TULE	< 5,000	20	< 4,980
WAH WAH	< 5,000	2	< 4,998
WHIRLWIND	5,000 to 25,000[6]	24	4,976 to 24,976
WHITE RIVER	37,000	4,328	32,672

NOTES:

[1] Includes Alkali Spring Flat

[2] Includes Muleshoe Valley

[3] Includes Patterson Wash Valley

[4] Geographic Valley (part of Pahranagat Basin)

[5] Includes over 26,000 acre-ft/yr appropriated by mining activities under construction

[6] System yield: The maximum amount of surface and ground water which can be removed from a hydrographic area each year for an indefinite period of time.

MINOR = less than 100 acre-ft/yr

Current ground-water use estimates are from the DRI and UWRL Industry Activities Inventories.

Perennial yield estimates are from various state and federal agencies except for the Sevier Desert which was calculated by Fugro National based on published data.

Negative ground-water availability numbers indicate overdraft conditions.

Zero current annual ground-water use numbers indicate withdrawal is very minor; however, a small amount of ground-water use may occur in these valleys.

ESTIMATED GROUND-WATER AVAILABILITY
NEVADA–UTAH

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE – BMO

TABLE 3-4

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siting area. Additional appropriations in these valleys are at the discretion of the state engineer. In these valleys, however, it may be possible to purchase or lease existing surface- and/or ground-water rights or import water from a neighboring valley where water is more plentiful for the approximate two- to three-year estimated construction period.

Estimating future water demands within the siting area was also included as part of the water-use inventories. Mining- and energy-related water uses were found to represent the only industrial activity with the potential for substantial increase in demands for the near term. New and revived mining activities and the cooling needs of possible new coal-fired electric power plants represent the chief competitors of MX for the available water. The potential increase in the water use for mining and energy represents an increase in total water demands in the study area of about 25 percent. It is unknown, however, whether or not all of these potential increases will be developed during the projected life of the MX project.

Results of the water-use inventories indicate that there is the potential for conflicts in use of the available water resources of the area. It is possible, however, that water supplies developed by mining or other industrial concerns could be leased by the Air Force for the short (two to three years) duration of construction in a particular ground-water basin to mitigate these conflicts.

3.8 CONTRIBUTIONS TO THE MX DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)

On 15 May 1980, Fugro National submitted a report to BMO and Henningson, Durham, and Richardson (HDR) of Santa Barbara, California, covering the results of the hydrogeologic investigation of 16 valleys and an overview of the water resources of the siting area. The report was titled "MX Siting Investigation, Water Resources Program, Summary for Draft Environmental Impact Statement" (FN-TR-38) and was intended to serve as the basis for the DEIS water-resources-related sections to be prepared by HDR. On 16 July, Fugro National was requested by the AFRCE to conduct a technical review of the DEIS prepared by HDR. This and several subsequent reviews were completed by 17 September.

4.0 AGGREGATE RESOURCES PROGRAM

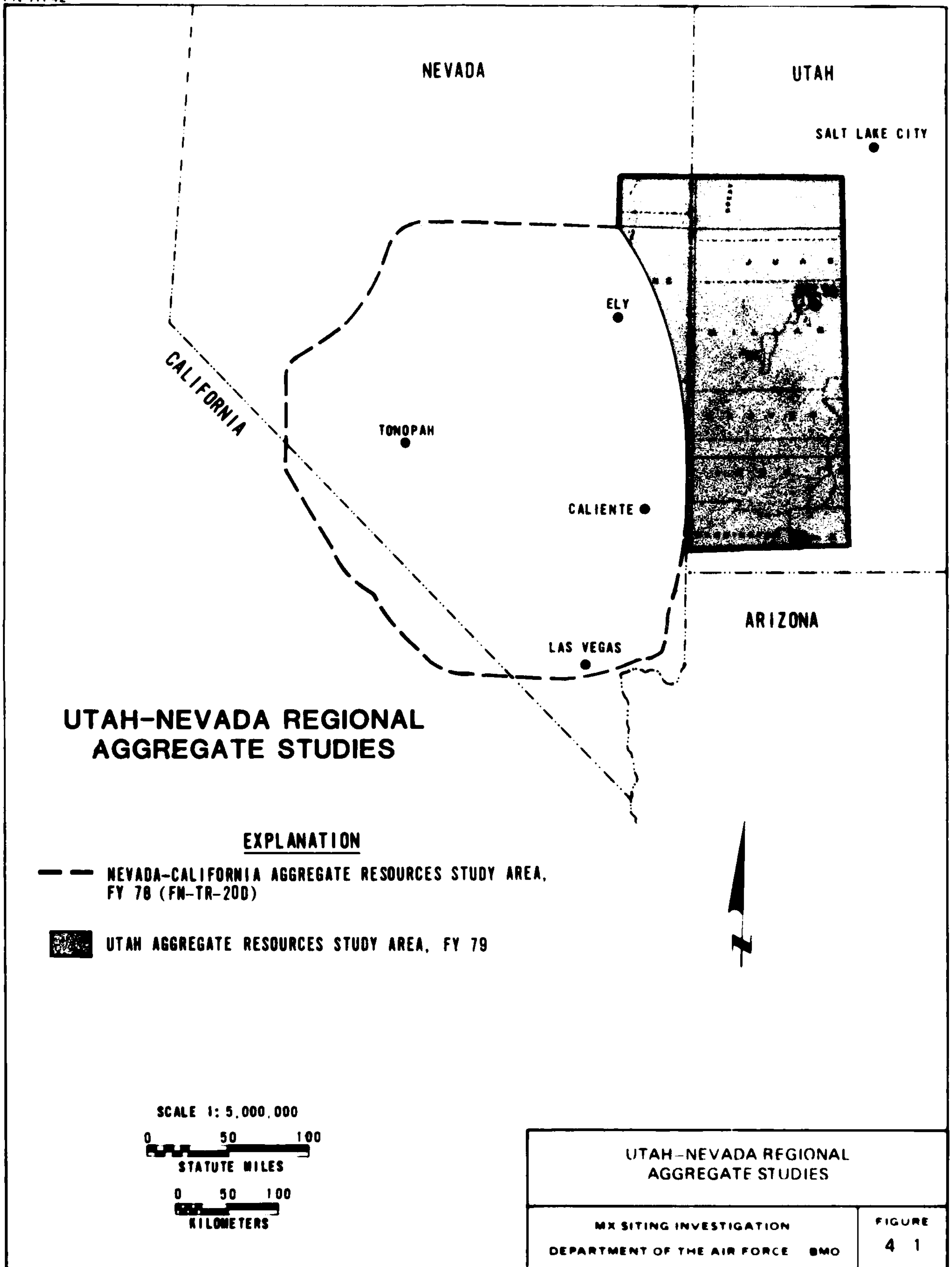
4.1 BACKGROUND

The MX Aggregate Resources Program began in 1977 with an initial Phase I investigation of the Department of Defense (DOD) and the Bureau of Land Management (BLM) lands in California, Nevada, Arizona, New Mexico, and Texas (FN-TR-20D). This program identified and ranked, on a regional basis, potential sources of concrete aggregate that could be used for construction of the MX system. Refinement of the potential MX siting area in FY 79 added portions of Utah and Nevada that were not studied in the initial Aggregate Resource Evaluation Investigation (AREI) of the Nevada-California areas (FN-TR-20D). This additional area was defined as the Utah Aggregate Resources Study Area (FN-TR-34); the boundaries of this area are shown in Figure 4-1.

Valley-Specific Aggregate Resources Studies (VSARS) were initiated in FY 79 and have continued into FY 80.

4.2 OBJECTIVES AND SCOPE

The primary objective of the Aggregate Resources Program is to identify and rank potential aggregate sources which are suitable for use in concrete structures and for road construction for the MX program. A three-phased program has been developed with each phase becoming more detailed. The first-phase regional study has been completed as discussed in Section 4.1. The second-phase studies consist of valley-specific studies to classify basin-fill deposits and rock for suitability in concrete mixes and for road construction. The third phase consists of detailed



UTAH-NEVADA REGIONAL AGGREGATE STUDIES

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

FIGURE 4 1

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28 NOV 80

studies within a valley to determine the vertical and lateral extent of potential borrow sites. The third phase of studies will be performed in FY 81.

The main activity in FY 80 has been the valley-specific program. The scope of work for a valley is as follows:

- o Identify and sample potential aggregate sources in the valley and adjacent mountains;
- o Perform laboratory tests - gradation, L.A. abrasion, $MgSO_4$ soundness, alkali reactivity, and specific gravity and absorption;
- o Compile and evaluate test data; and
- o Prepare valley reports with the results of the study and conclusions.

4.3 STATUS OF PROGRAM

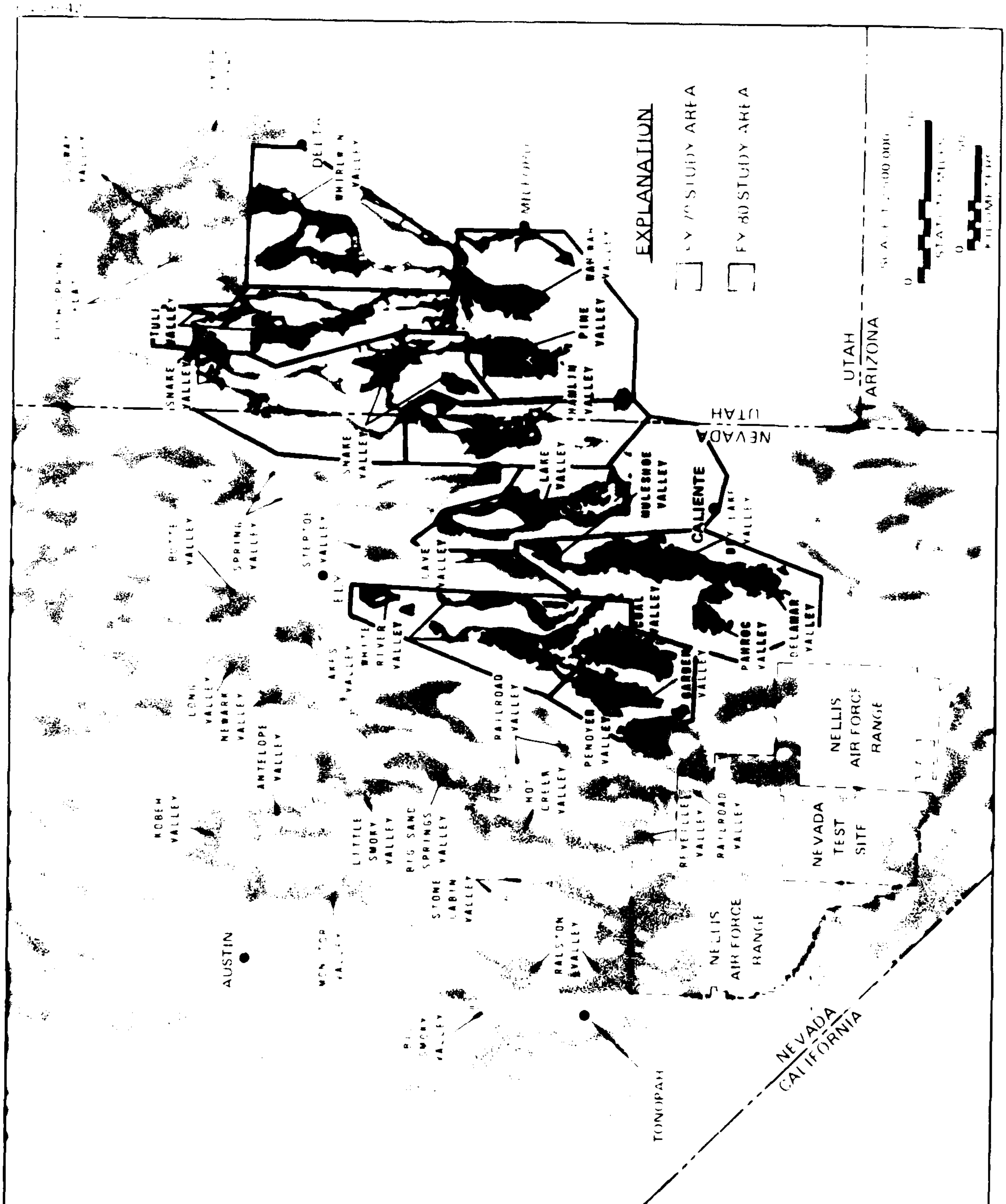
The progress of the Aggregate Resources Program is summarized in Table 4-1. Field studies were completed in three valleys in September 1979 and in 11 more valleys in FY 80 (Figure 4-2). Reports for the first eight valleys investigated were submitted in June 1980 and the remaining reports are to be submitted in FY 81.

4.4 RESULTS AND CONCLUSIONS

From the regional studies, it is concluded that sufficient volumes of material to satisfy the aggregate requirement of the MX system appear to be available from a variety of basin-fill and/or rock sources within the study area.

4.4.1 Results

The most extensive potential basin-fill sources are found in alluvial fan deposits which are distributed throughout the



VALLEY SPECIFIC AGGREGATE RESOURCES STUDY

MX SITING INVESTIGATION

DEPARTMENT OF THE AIR FORCE BMO

FIGURE 4 2

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VALLEY	FIELD WORK COMPLETED	REPORT DATE
Whirlwind	September 1979	June 1980
Hamlin	September 1979	June 1980
Snake	September 1979	June 1980
White River	October 1979	June 1980
Dry Lake	November 1979	June 1980
Muleshoe	November 1979	June 1980
Delamar	November 1979	June 1980
Pahroc	November 1979	June 1980
Pine	August 1980	February 1981 (est)
Wah Wah	August 1980	February 1981 (est)
Tule	August 1980	May 1981 (est)
Lake	September 1980	February 1981 (est)
Garden	September 1980	July 1981 (est)
Coal	September 1980	July 1981 (est)

SUMMARY OF VALLEY - SPECIFIC AGGREGATE RESOURCES STUDIES

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE — BMO

TABLE 4 - 1

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entire area. Older lacustrine deposits are of apparent higher quality than alluvial fan units but are confined to the northeastern portion of the siting area. The gradation of sand and gravel in both of these deposits may be a limiting factor in the processing of the material for high strength concrete and road-base aggregates.

Potential rock sources that will probably yield high quality processed aggregate are widely distributed throughout the study area. Most mountain ranges that border the basin areas are comprised wholly or in part of Paleozoic and Precambrian carbonate and quartzitic rocks with scattered Quaternary basaltic rocks located in valley areas. Quartzitic rocks are typically of higher quality than limestone and dolomite carbonate rocks but are areally more limited. Basaltic outcrops are restricted to the eastern portion of the study area and are less desirable sources for concrete aggregate than either carbonate or quartzitic rocks.

4.4.2 Conclusions

From the valley studies, it is concluded that all investigated valleys appear to have adequate gravel, sand, and crushed rock sources, although individual quality and quantity vary. Valleys influenced by Pleistocene Lake Bonneville (Whirlwind, Wah Wah, Snake, Tule) have abundant, well-defined, high quality gravel reserves deposited in older lacustrine shoreline landforms. Valleys where alluvial processes were dominant possess somewhat lower quality and less distinct gravel reserves deposited in alluvial fans.

High quality sources of sand are of limited distribution. The only major sources of suitable high quality sand are located in older lacustrine or alluvial deposits derived directly from granitic rock sources (e.g., Deep Creek Range bordering Snake Valley).

Sources of high quality crushed rock are available for all valleys. Paleozoic and Precambrian carbonate and quartzitic rock units are extensive and widely distributed in numerous Utah and Nevada formations. In addition, individual units within widespread undifferentiated Tertiary volcanics will also supply acceptable crushed rock sources.

High quality rock sources are generally more readily available than high quality basin-fill sources. However, because of the higher cost of developing aggregate from rock sources, it generally will be more economical to develop available basin-fill sources.

5.0 TOPOGRAPHIC MAPPING AND AERIAL PHOTOS

5.1 BACKGROUND

Topographic map sheets at a scale of 1:4800 (1"=400') (1 cm= 48 m) were produced for Dry Lake Valley, Nevada, in FY 79 as part of the MX shelter layout methodology. These map sheets were photographically reduced to a scale of 1:9600, and layouts were done at both scales. The contour interval was 5 feet (1.5 m) for the south half of the valley and 10 feet (3.0 m) for the north half. From the study, it was concluded that a scale of 1:9600 was the preferred scale for future shelter layout studies.

5.2 FY 80 PROGRAM

5.2.1 Maps at 1:9600 Scale

The decision was made to continue producing maps of selected valleys at a scale of 1:9600 so that more refined layouts could be completed as demonstrated in the methodology studies in Dry Lake Valley. The valleys selected were those near Dry Lake Valley: Muleshoe, Delamar, Pahroc, and Cave. For these maps, a 10-foot contour interval was selected.

In April and May 1980, the AFRCE proposed to initiate field surveys in selected Nevada and Utah valleys for purposes of testing cluster layout procedures and determining potential field problems in actual shelter siting. The valleys selected for this study were Dry Lake Valley, Nevada, and Pine and Wah Wah valleys, Utah. In order to produce the required accuracy for these methodology studies, it was decided to use the 1:9600

topographic maps. Since no maps of that scale existed for the Utah valleys, maps were developed. As in the other 1:9600-mapping programs, the existing aerial photography at a scale 1:25,000 was used.

5.2.2 Maps at 1:62,500 Scale

Fugro National was directed to start working on 1:62,500 scale shelter layouts for all valleys in the DDA in February 1980 to support the land withdrawal application. In reviewing the available topographic maps, it was determined that the most detailed maps for five valleys were the existing U. S. Geological Survey (USGS) 2° topographic map sheets (1:250,000, 1" 4 miles) (1 cm=2.5 km). It was concluded that these maps were not of sufficient detail for layouts. A program was initiated to produce new maps at a scale of 1:62,500 with 10-foot contours. The five valleys identified were: Garden, Coal, Penoyer, Railroad, and the west half of Snake (i.e., the portion in Nevada).

5.3 STATUS OF MAPPING PROGRAM

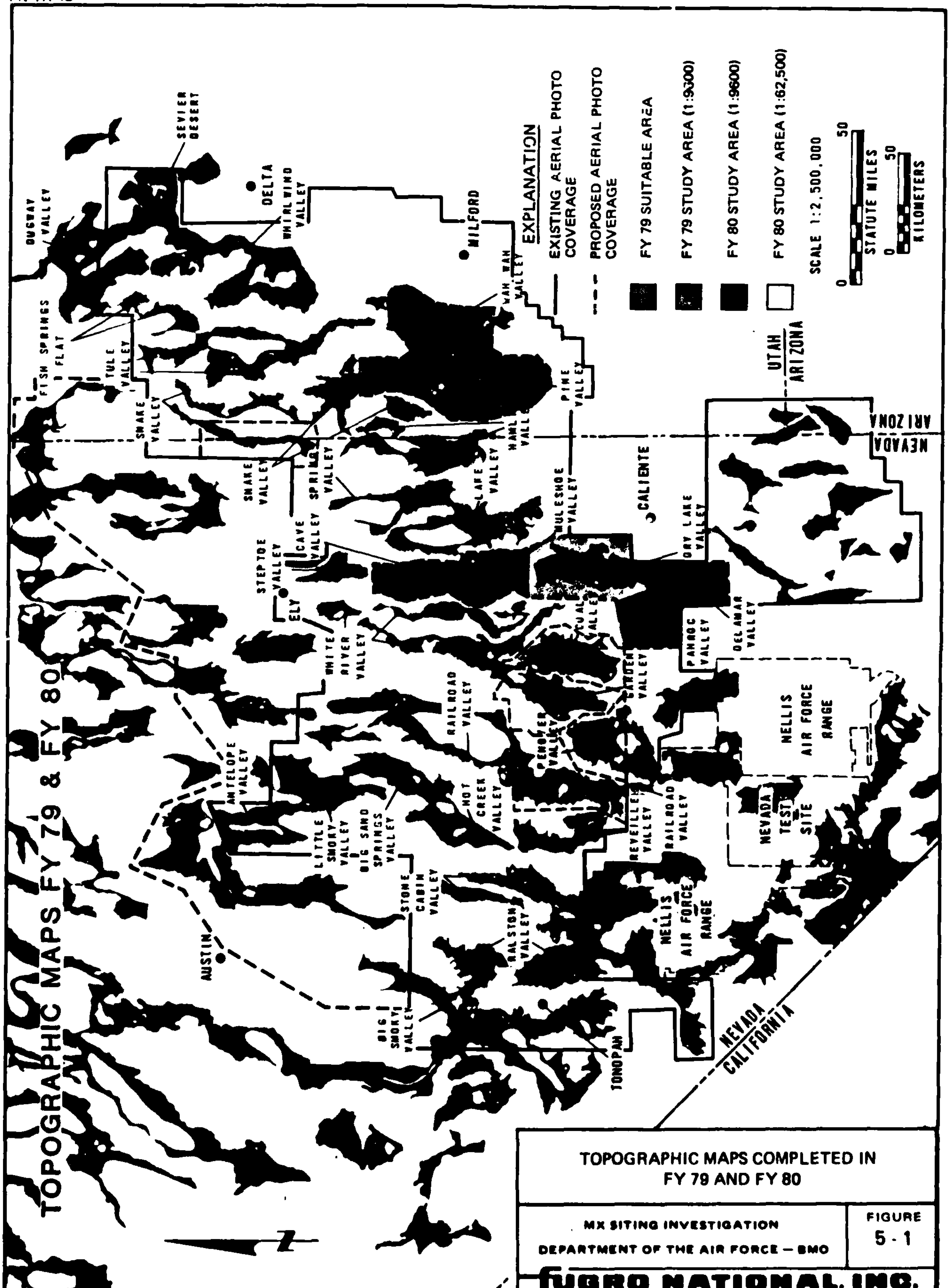
The topographic maps completed in FY 80 are shown in Figure 5-1 and summarized in the following table:

TOPOGRAPHIC MAPS COMPLETED IN FY 80

1:9600 Scale	1:62,500 Scale
Muleshoe	Garden
Delamar	Coal
Pahroc	Penoyer
Cave	Railroad
Pine	Snake (west half)
Wah Wah	

5.4 AERIAL PHOTOS

As Verification and layout studies progressed and suitable area decreased, it became apparent that additional valleys would be



TOPOGRAPHIC MAPS COMPLETED IN FY 79 AND FY 80

MX SITING INVESTIGATION

DEPARTMENT OF THE AIR FORCE — BMO

FIGURE 5-1

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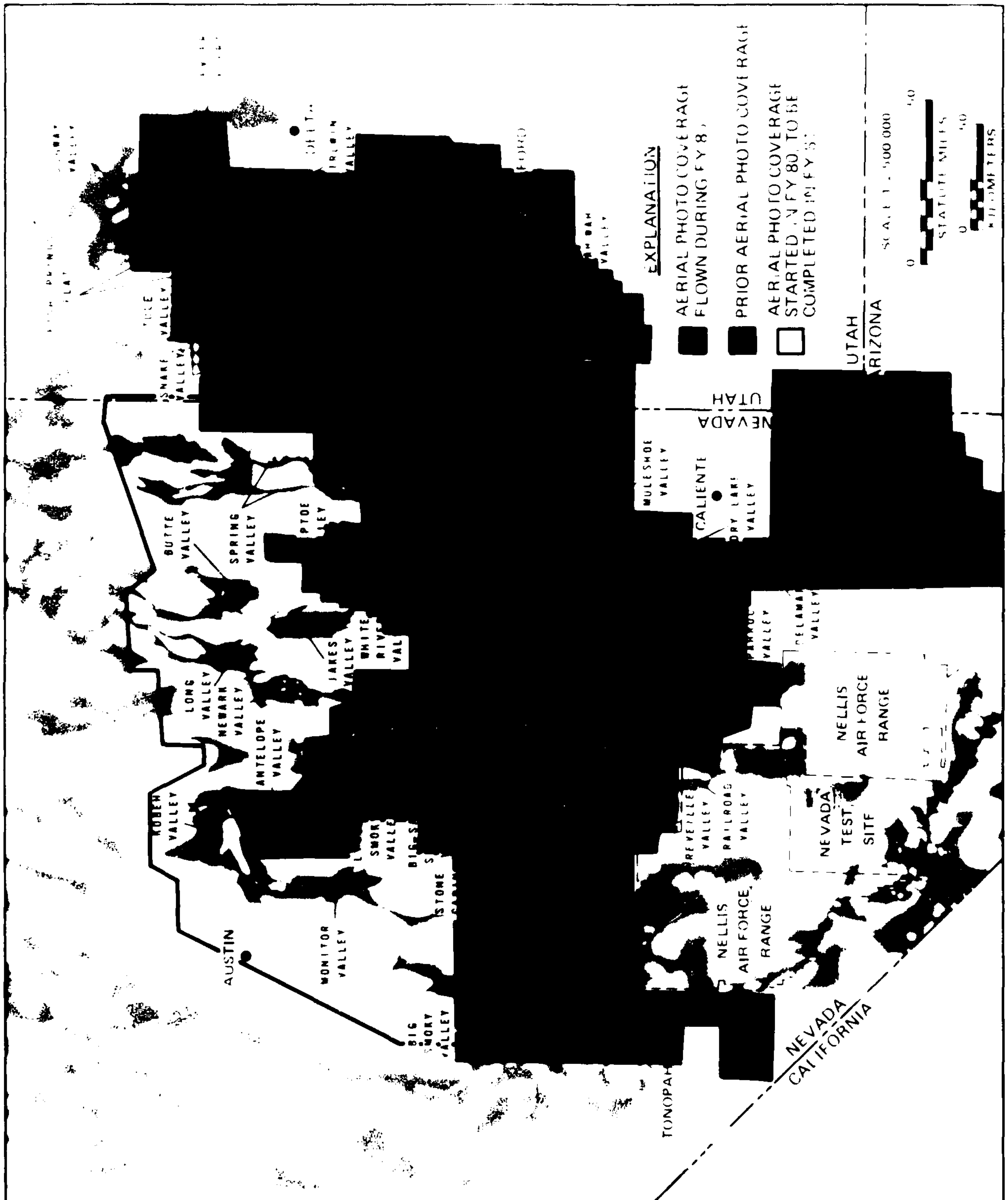
needed if the entire MX system were to be deployed in Nevada and Utah. Six "northern" valleys were identified as possible deployment areas: Monitor, Kobeh, Newark, Long, Butte, and Jakes (Figure 5-2). The decision was made to obtain new color aerial photos of the valleys at a scale of 1:25,000 with sufficient overlap for stereoscopic coverage. Flying for the new task started in August 1980. As of the end of October, the flying and film processing were 90 percent completed and one-third of the prints were available.



FY 80 NEVADA - UTAH STUDY AREA
STATUS OF AERIAL PHOTO COVERAGE

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

FIGURE 5-2

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6.0 SHELTER LAYOUT STUDIES

6.1 BACKGROUND

Fugro National began multiple protective structure (shelter) layouts in FY 79. These first studies were initiated to develop a methodology and procedures using Dry Lake Valley, Nevada, as the study area. At that time, the loop concept was being considered and a variety of shelter spacings, ranging from 5000 to 7000 feet (1520 to 2140 m), were applied. Initial layouts were performed at a scale of 1:62,500 (1" ≃ 1 mile) (1 cm=625 m) with some experimentation of transferring these layouts to larger map scales (1:4800 and 1:9600). Based on these studies, it was concluded that 1:9600 (1"=800') (1 cm=96 m) was a good scale for preparing preliminary layouts. At that scale, it is possible to make adjustments for terrain and geotechnical conditions which were not possible at the smaller scale of 1:62,500.

6.2 FY 80 PROGRAM

The original plan for FY 80 was to prepare layouts for six valleys at a scale of 1:62,500 and then do more detailed layouts of the same valleys at a scale of 1:9600. The valleys selected were those adjacent to Dry Lake Valley; the same valleys in which topographic maps at a scale of 1:9600 were also being made (Section 5.2).

In February 1980, Fugro National was redirected to prepare shelter layouts for all valleys in the DDA at a scale of 1:62,500 for purposes of supporting the land withdrawal application. In the same month, a shelter layout report was submitted for the

previous methodology studies in Dry Lake Valley. At the time of the redirection, final decisions had not been made on the basing mode and shelter spacing.

Between February and May, shelter layouts were prepared for a variety of concepts and spacings. On 6 June 1980, Fugro National received from the BMO/AFRCE a document entitled, "MX Site Layout Requirement for a Horizontal Shelter with Separate Transporter and Erector Launcher System - Nevada/Utah." This document provided the criteria for performing layouts since the date of the document.

As work was progressing on the valley layouts in the last four months of FY 80, Fugro National was also requested to produce regional layouts (scale 1:500,000) of the entire 200-cluster system in Nevada and Utah.

6.3 OBJECTIVES

The redirection of the layout program in February 1980 was necessary in order to meet the requirements of land withdrawal. The land withdrawal package must include a legal description of federal lands to be withdrawn for MX. In order to complete the task, it is necessary to complete the shelter layouts for each valley in the DDA. The final product is a legal description for each 2.5-acre parcel for each of the 4600 shelter sites. Legal descriptions are also required for all other MX structures requiring withdrawn federal land (i.e., CMFs, RSSs, Area Support Centers [ASCs], OB, etc.).

6.4 SHELTER LAYOUT CRITERIA

The key elements of layout criteria, as identified in the 6 June 1980 BMO/AFRCE document, are as follows:

- o Open hexagonal pattern;
- o Shelter spacing of 5200 feet $\pm$ 200 feet (1580 m $\pm$ 60 m);
- o Not more than three nearest neighbors;
- o A backfill concept with space for 34 or 35 shelters in each cluster but with only 23 sited;
- o Shelter orientation away from the nearest neighbor by 55° to 60° degrees; and
- o North-south orientation of clusters where possible.

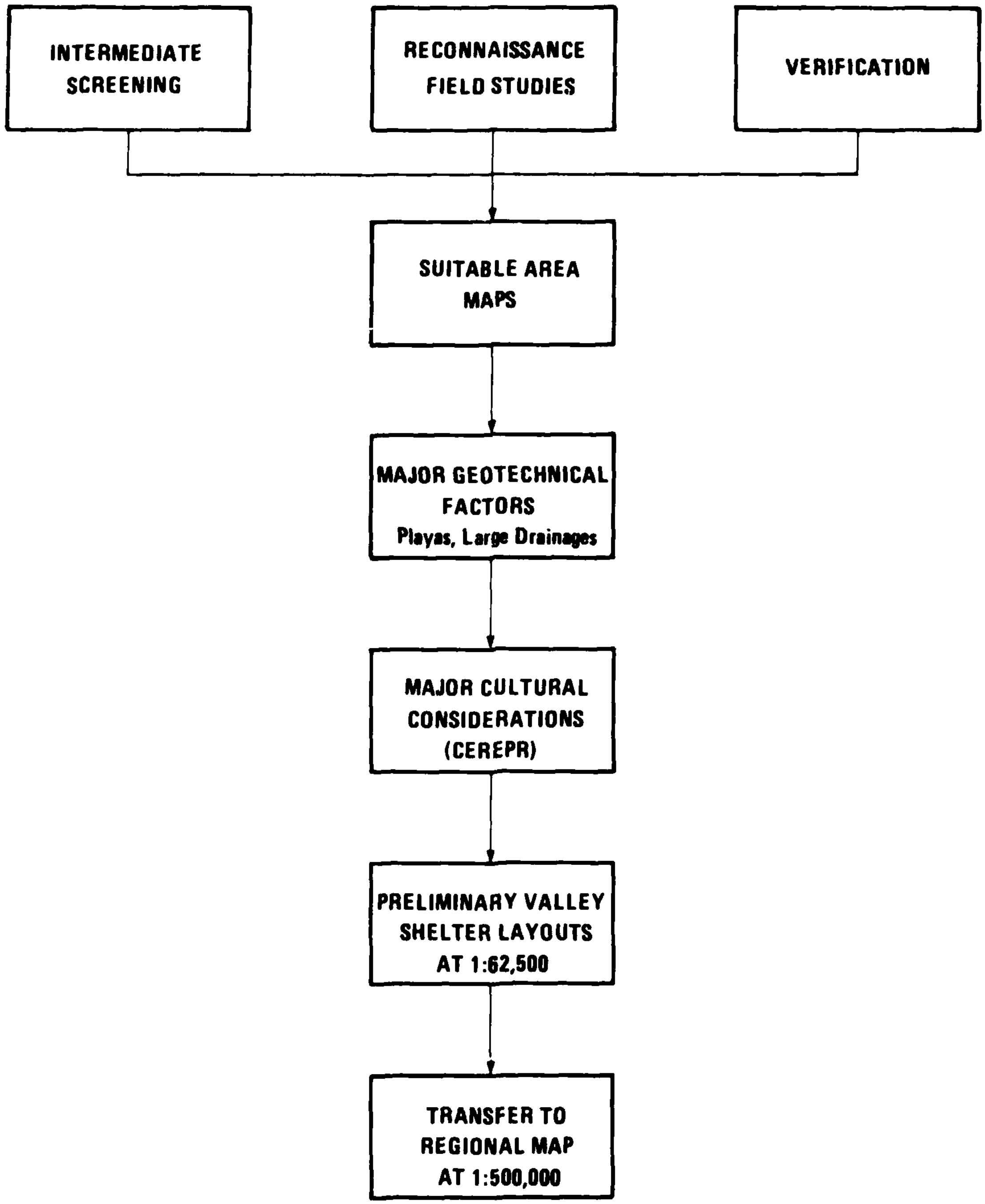
In addition to these major criteria, the document listed areas to be avoided and a number of quantity-distance requirements for shelters and the Designated Transportation Network (DTN). As work progressed on the layouts, additional layout criteria or considerations were developed. These later considerations were applied on an "avoid-if-possible" basis and are:

- o Avoid adverse terrain;
- o Avoid active playas;
- o Avoid large drainages;
- o Avoid active or potentially active faults; and
- o Avoid private property and patented mining claims.

6.5 METHODOLOGY

6.5.1 Regional Layouts

The regional layout methodology is shown in the flow chart (Figure 6-1). The starting point in the layout process is a suitable area map of the valley. As shown in the flow chart,



REGIONAL SHELTER LAYOUT METHODOLOGY

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE — BMO

FIGURE 6-1

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the determination of suitable area is from Intermediate Screening results, reconnaissance field surveys, and Verification studies. Since Verification studies are still in progress, geotechnical suitability is based on previous studies for some valleys. For these valleys, the boundaries will change when Verification studies are completed.

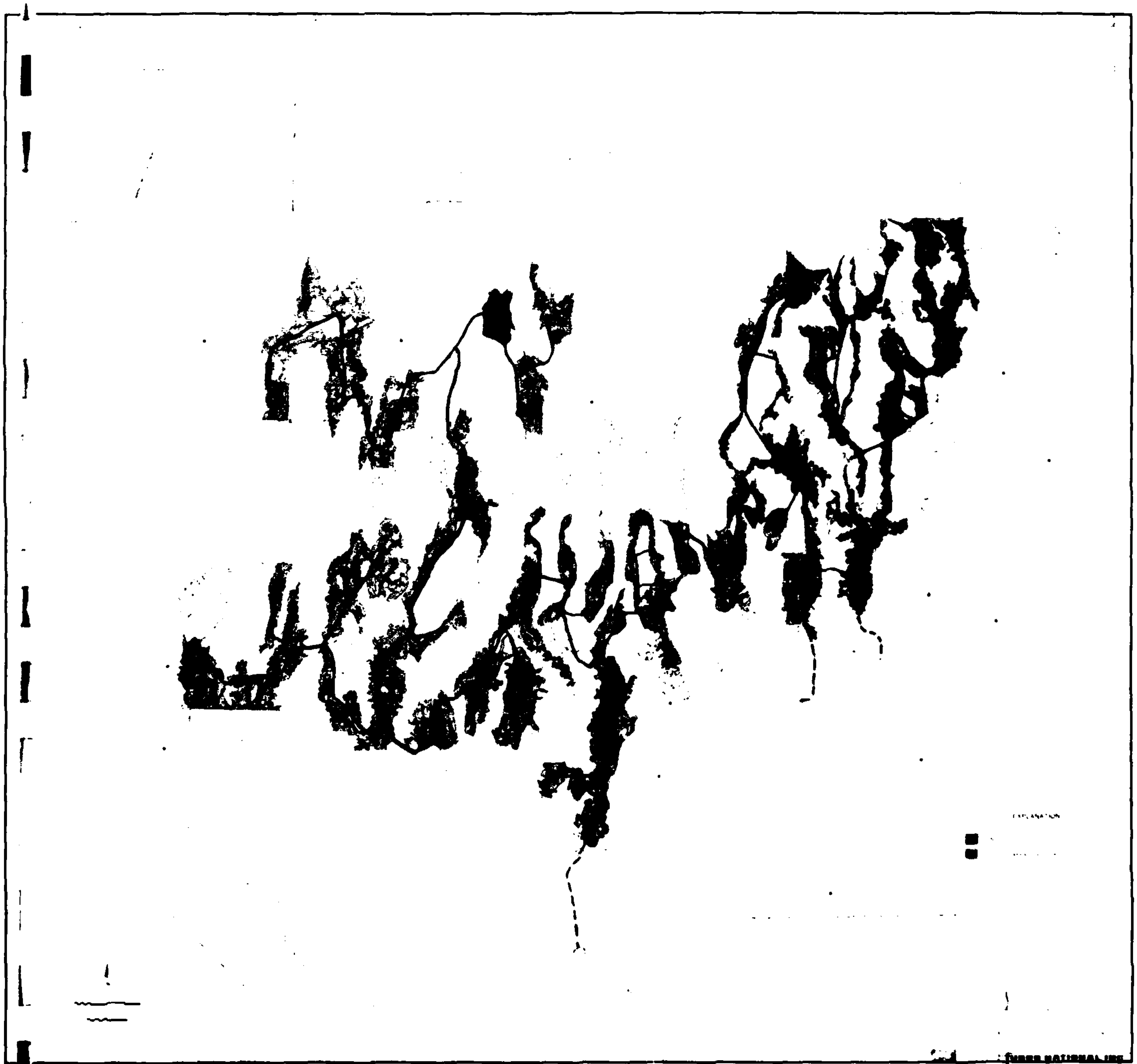
The regional layouts at a scale of 1:500,000 are produced by preparing preliminary valley layouts at a scale of 1:62,500. Using this approach, regional layouts were produced on the following dates: 1 July, 17 July, 2 September, and 26 September. The most recent regional layout is shown in Figure 6-2 and also as Drawing 6-1.

Each new regional layout shows the latest changes in suitable area and improvements in cluster layouts for those valleys where detailed cluster layouts have been completed. This is a continuing process which will not be completed until:

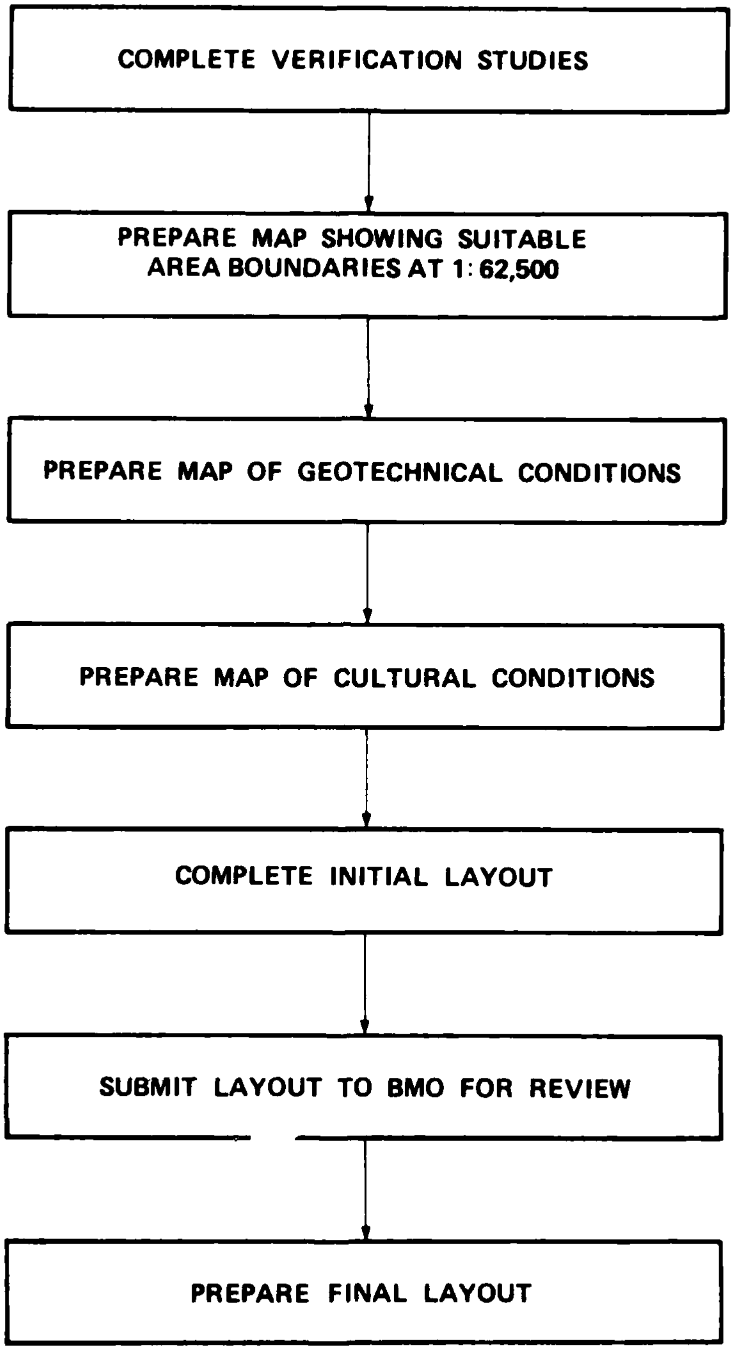
- o Verification studies have been completed and geotechnical suitable area boundaries have been refined;
- o Detailed valley layouts have been completed; and
- o Final routing of the DTN has been completed.

6.5.2 Valley Layouts

The procedures for valley layouts are shown in the flow chart, Figure 6-3. Prior to starting a layout, it is necessary to have a map showing the suitable area boundaries and have information on the geotechnical and cultural conditions. The procedures are



5200 FOOT 2/3 FILLED HEXAGONAL
LINEAR MPS REGIONAL LAYOUT
(200 CLUSTERS)
FIGURE 6 - 2



VALLEY SHELTER LAYOUT METHODOLOGY

MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE — BMO	FIGURE 6-3

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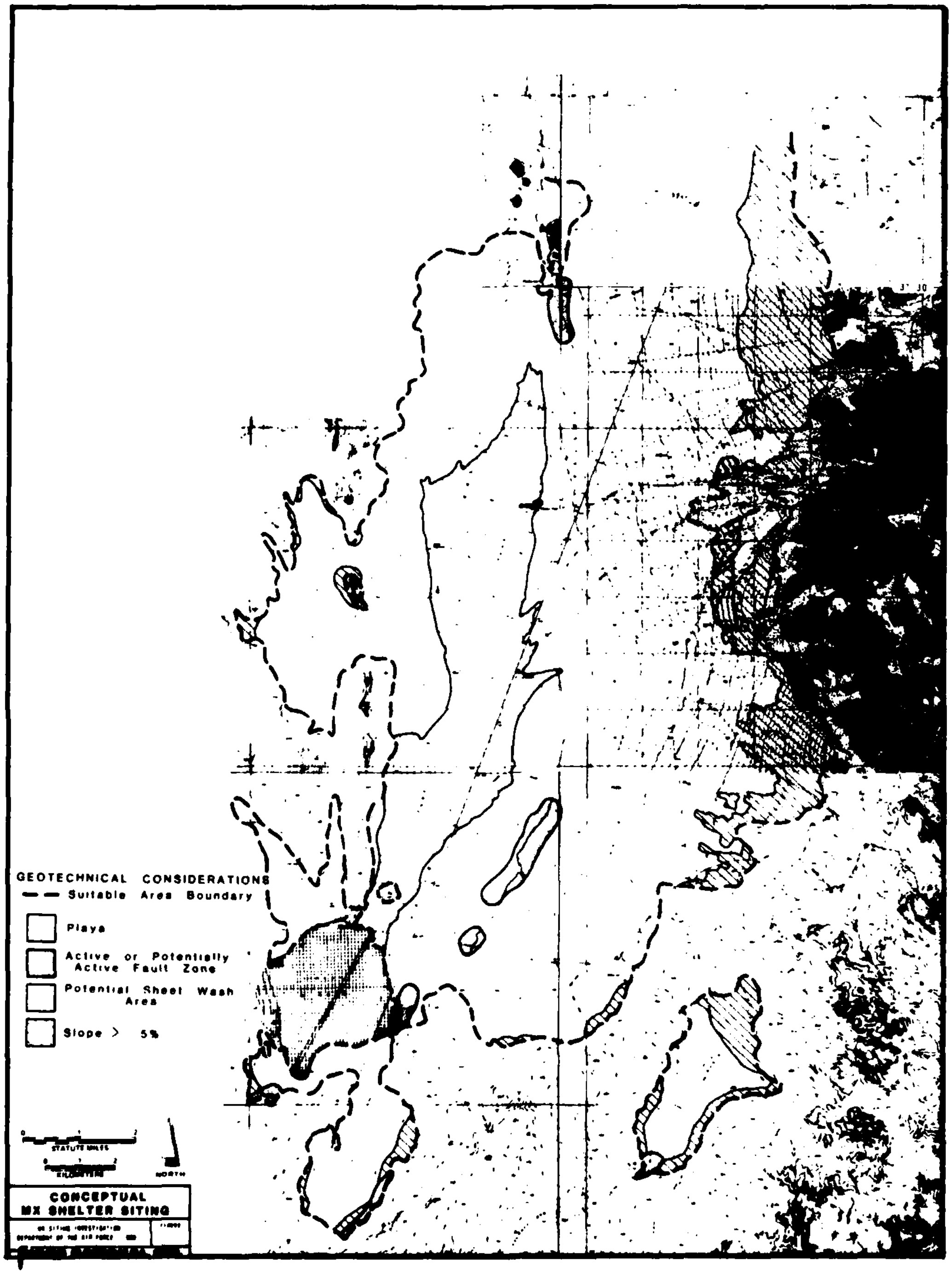
demonstrated conceptually in Figures 6-4, 6-5, and 6-6. Figure 6-4 shows the suitable area boundary and identifies the geotechnical factors that have been considered: a playa, active or potentially active fault zones, potential sheet wash flood areas, and average slopes greater than five percent. Figure 6-5 shows the seven cultural factors which have been considered. The continuous north-northeast trending corridor represents the quantity-distance standoff criteria applied for a proposed powerline. Figure 6-6 shows the conceptual shelter layout which consists of two clusters connected to the DTN at the north end. Although the figures are conceptual, they do illustrate that a number of factors influence the layouts and not all of the suitable area is usable for MX siting.

The status of valley layouts, as of 31 October 1980, is shown in Figure 6-7. Layouts were in various stages of development for 19 valleys. Layouts for six valleys has been submitted to the AFRCE for review.



GEOTECHNICAL CONSIDERATIONS,
CONCEPTUAL SHELTER LAYOUTS

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE – BMO

FIGURE
6 - 4

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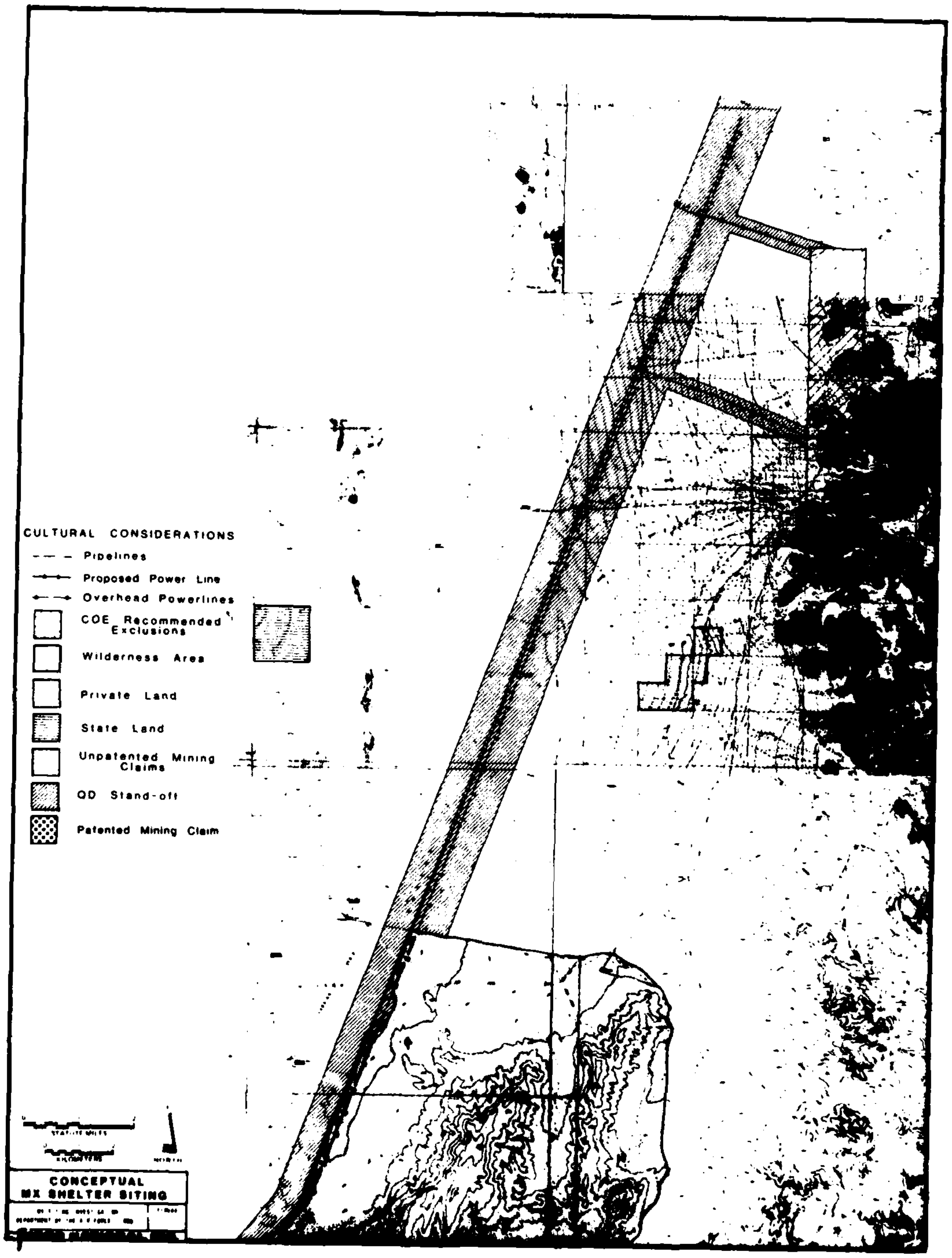

CULTURAL CONSIDERATIONS, CONCEPTUAL SHELTER LAYOUTS

MX SITING INVESTIGATION

DEPARTMENT OF THE AIR FORCE — BMO

FIGURE 6-5

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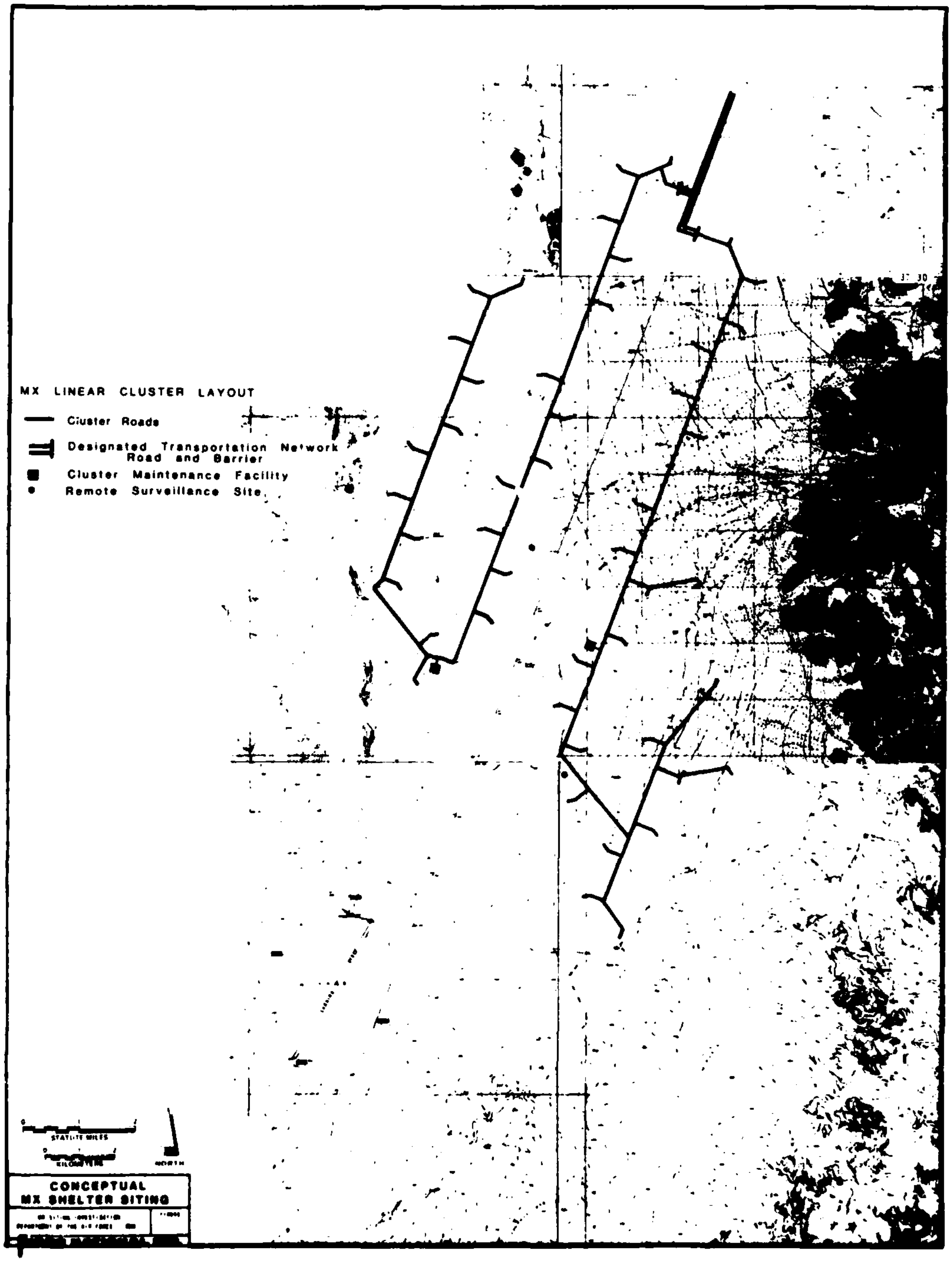

CONCEPTUAL CLUSTER LAYOUT

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FIGURE 6-6

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VALLEY	LAYOUT IN PROGRESS	IN HOUSE REVIEW	SUBMITTED TO AFRCE			
UTAH						
SEVIER	●					
DUGWAY	●					
WHIRLWIND						
FISH SPRINGS	●					
TULE	●					
SNAKE	●					
WAH WAH	●	●	●			
PINE	●	●	●			
SEVIER LAKE						
NEVADA						
HAMLIN	●	●				
SPRING						
LAKE						
MULESHOE	●	●	●			
DRY LAKE	●	●	●			
DELAMAR	●	●	●			
PAHROC	●	●	●			
STEPTOE						
CAVE	●	●				
WHITE RIVER						
COAL	●					
GARDEN	●					
PENOYER	●	●				
RAILROAD						
ANTELOPE						
LITTLE SMOKY	●					
BIG SAND SPRINGS	●					
HOT CREEK						
REVEILLE	●					
STONE CABIN						
RALSTON						
BIG SMOKY						
MONITOR						
KOBEH						
NEWARK						
LONG						
BUTTE						
JAKES						

31 OCTOBER 1980

VALLEY LAYOUTS STATUS

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE – BMO

FIGURE 6-7

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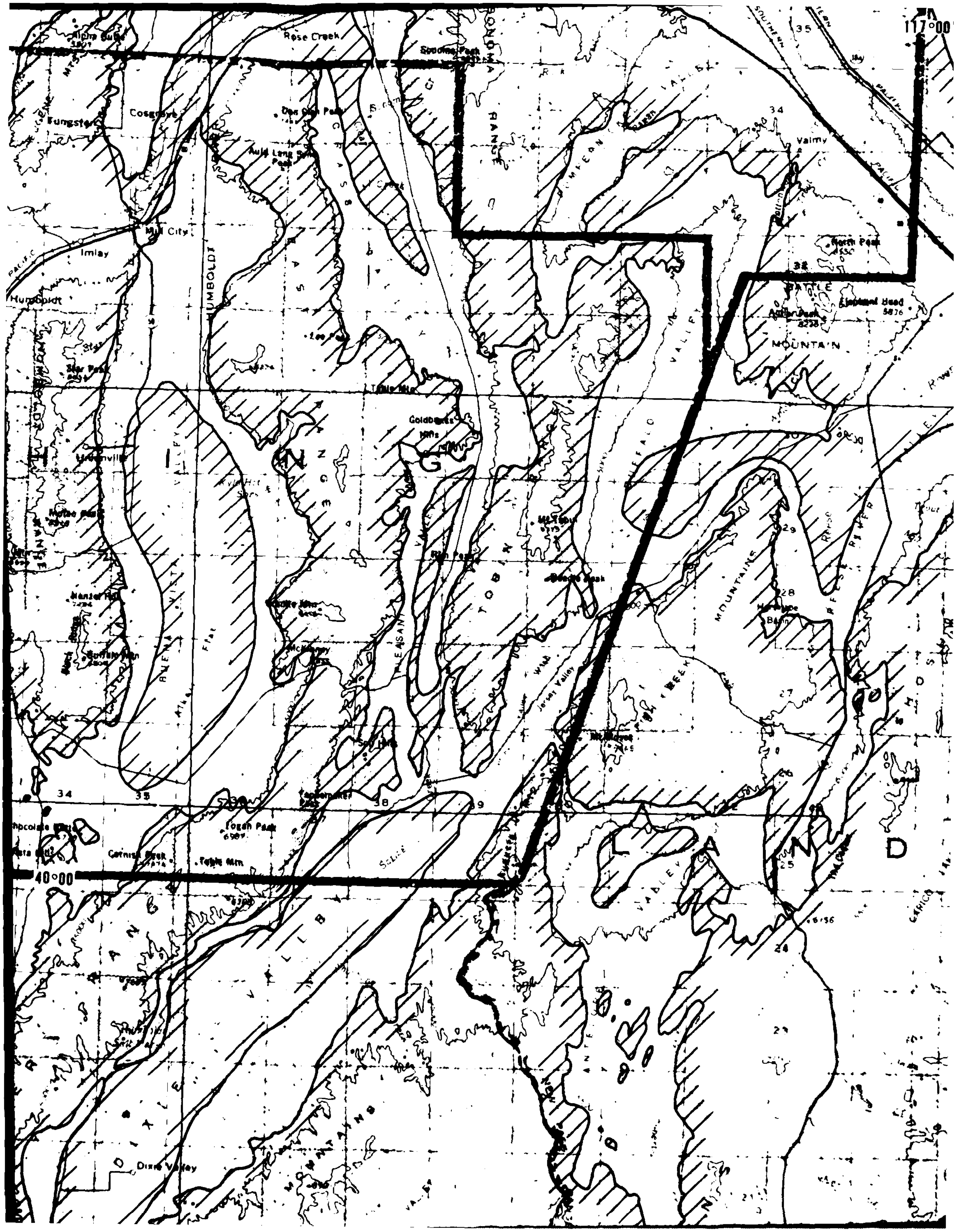

117°00'
40°00'
Rose Creek
Cosgrave
Tungsten
Mill City
Imlay
Humboldt
HUMBOLDT
Star Peak
Auld Lang Syne Peak
Table Mtn
Goldbanks Hills
TOBIN
PLEASANT
BUFFALO
VALLEY
Valmy
North Peak
BATTLE
MOUNTAIN
Antler Peak
Elephant Head
MOUNTAINS
Horseshoe Basin
Jersey Valley
Dixie Valley
Tobin Peak
Table Mtn
D

AD-A112 535 FUGRO NATIONAL INC LONG BEACH CA F/G 13/2
EXECUTIVE SUMMARY REPORT - FY80 GEOTECHNICAL SITING INVESTIGATI--ETC(U)
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UNCLASSIFIED FN-TR-42 NL

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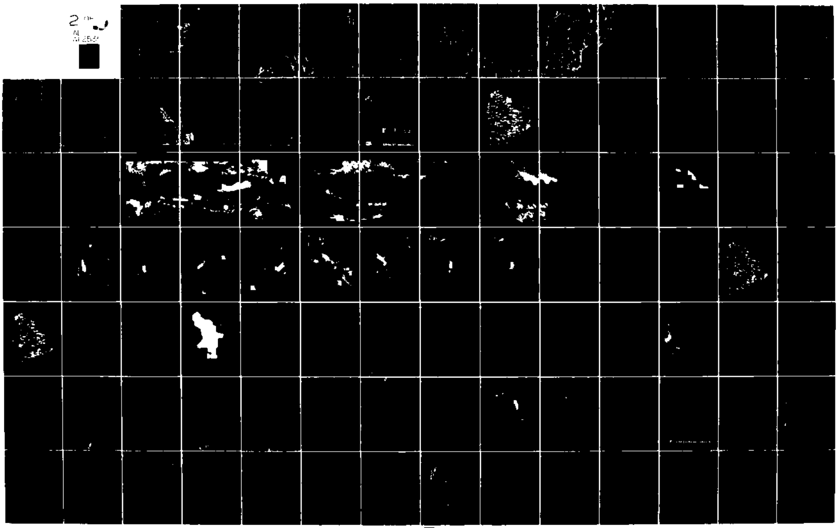
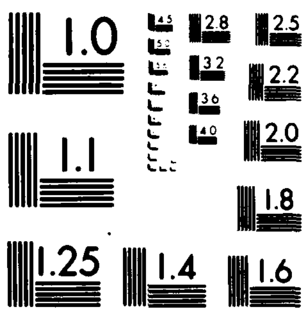
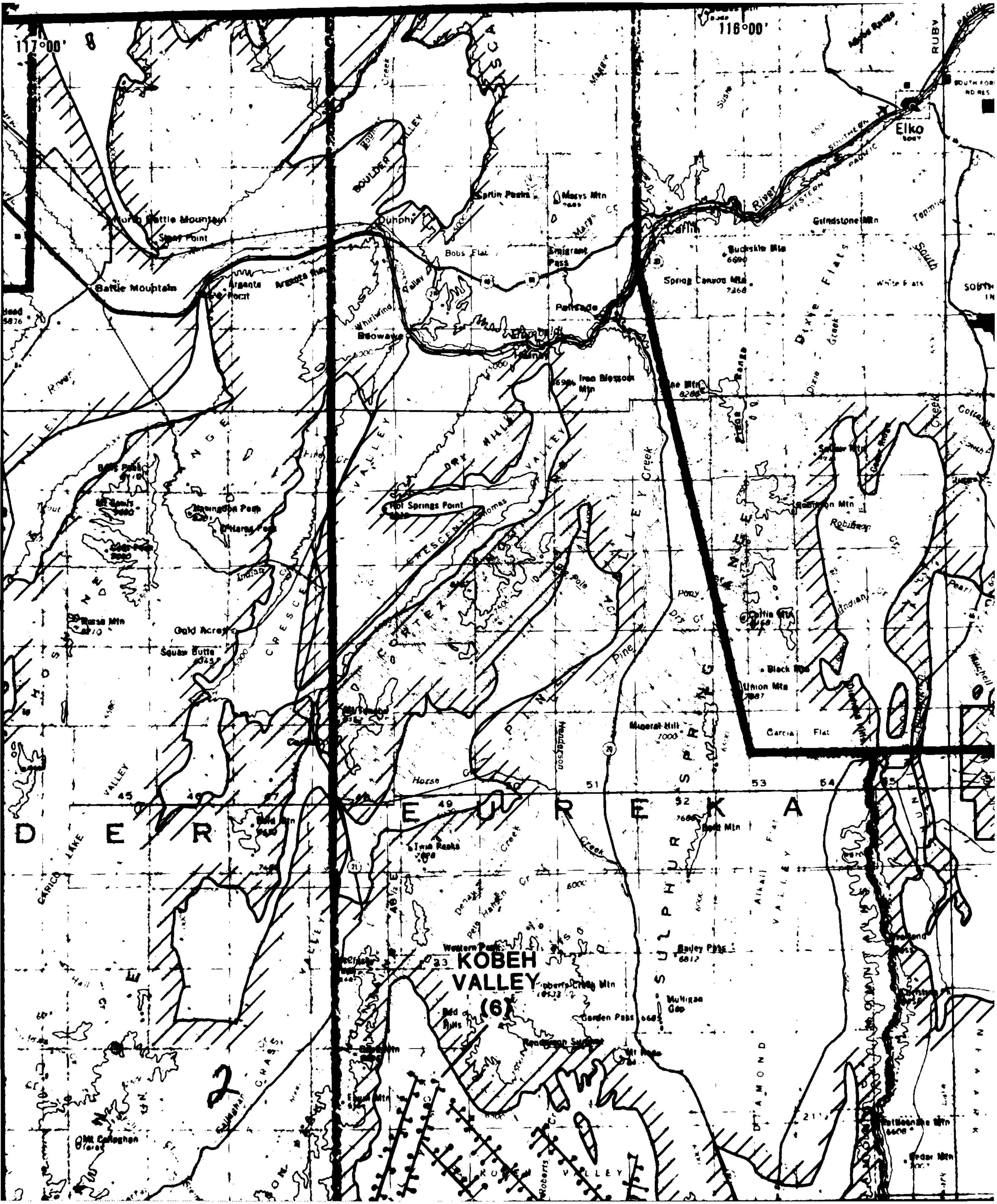
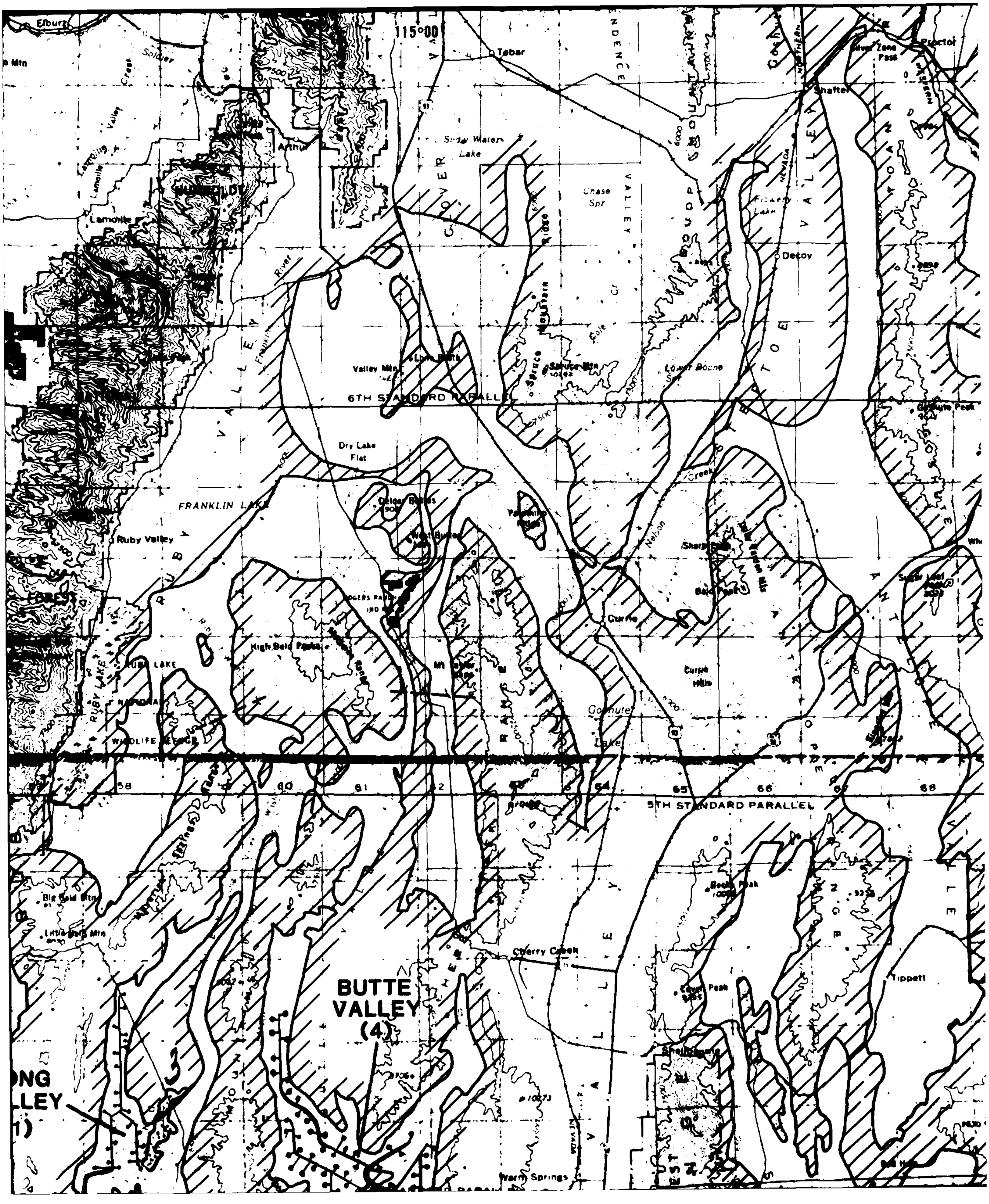




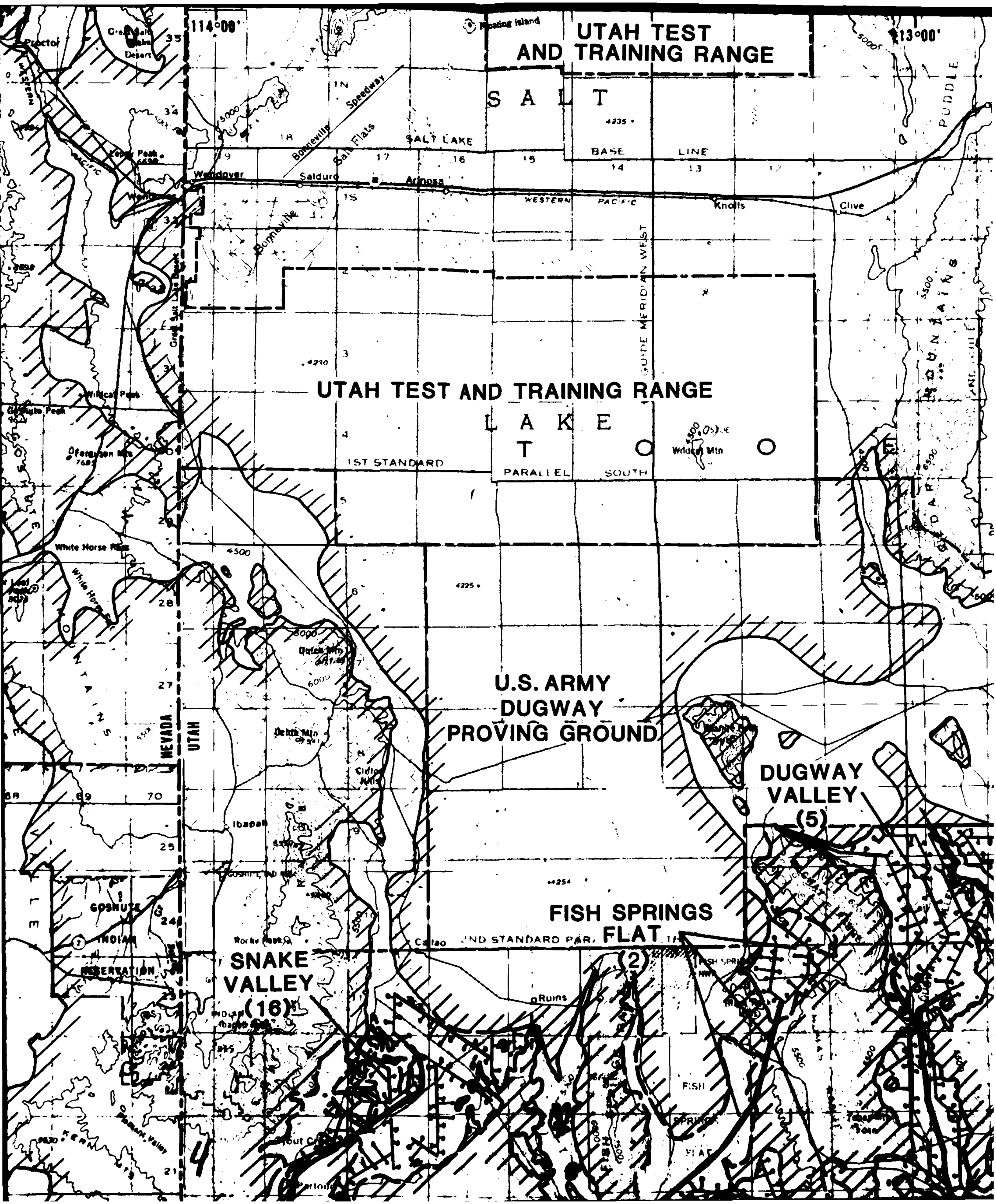
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A



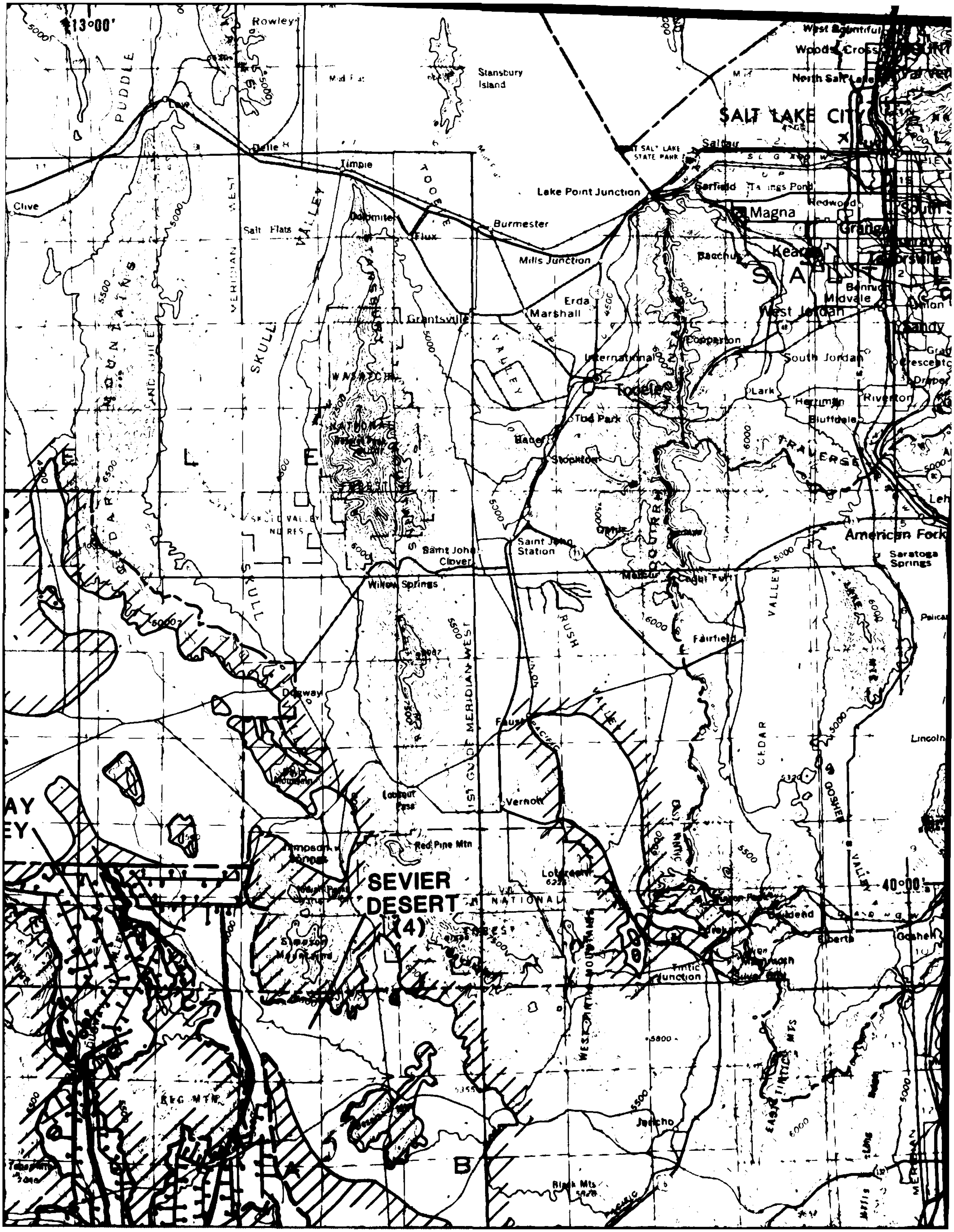
117°00'
116°00'
Elko
Carlin
Battle Mountain
North Battle Mountain
Argenta
Palisade
Dunphy
Beowawe
Bobs Flat
Emigrant Pass
River
Buckskin Mtn
6690
Spring Canyon Mtn
7368
Grindstone Mtn
White Flats
Dixie Flats
Iron Blossom Mtn
DRY HILLS
CRESCENT
VALLEY
Hot Springs Point
Gold Acres
Squaw Butte
Pony
Dry Cr
Pine
Henderson
Mineral Hill
7000
Union Mtn
Black Mtn
Garcia Flat
Indian Cr
45
46
47
49
51
52
53
54
D E R
E U R E K A
Twin Peaks
Western Peak
KOBEH
VALLEY
(6)
Bailey Pass
6812
Mulligan Gap
Garden Pass
Alkali Flat
SULPHUR SPRING
DIAMOND
Mt Callaghan
Rattlesnake Mtn
Cedar Mtn
GRASS
VALLEY
2



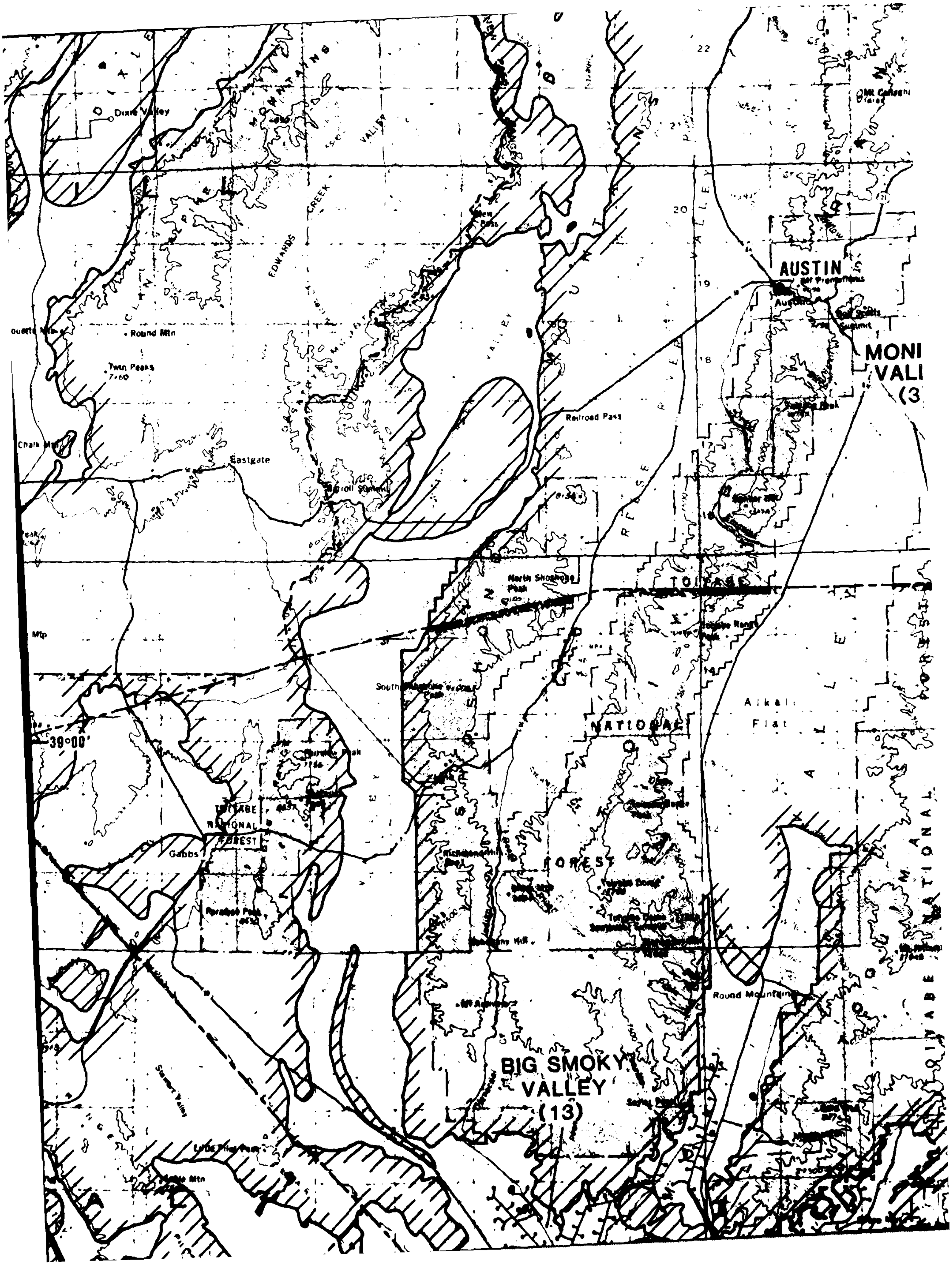
Elburz
115°00'
Tobar
Proctor
Silver Zone Pass
Shafter
Snow Water Lake
Arthur
Lamoille
Chase Spr
Flowery Lake
Decoy
Valley Mtn
Spruce Mtn
Lower Boone Spr
6TH STANDARD PARALLEL
Dry Lake Flat
FRANKLIN LAKE
Ruby Valley
Sharp Peak
Bald Peak
Currie
Currie Hills
High Bald Peak
RUBY LAKE
WILDLIFE REFUGE
Goshute
Lake
58
60
61
62
64
65
66
68
5TH STANDARD PARALLEL
Big Bald Mtn
Becks Peak
Cherry Creek
Tippett
BUTTE VALLEY (4)
Warm Springs



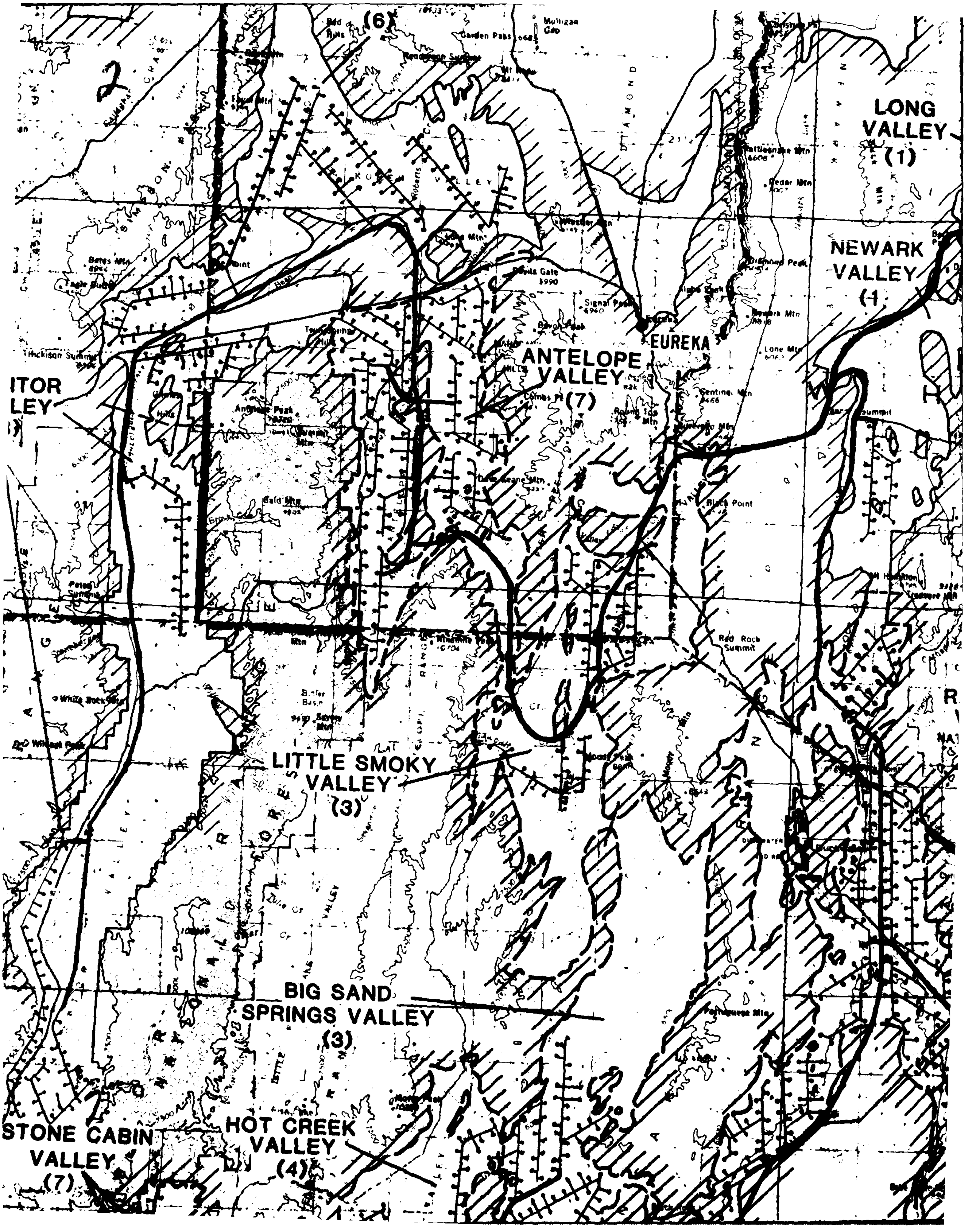
UTAH TEST AND TRAINING RANGE
114°00'
113°00'
SALT
SALT LAKE
BASE LINE
Bonneville Salt Flats Speedway
Wendover
Salduro
Arinosa
WESTERN PACIFIC
Knolls
Clive
Floating Island
UTAH TEST AND TRAINING RANGE
LAKE
TOOO
1ST STANDARD PARALLEL SOUTH
GUIDE MERIDIAN WEST
Wildcat Mtn
Wildcat Peak
White Horse Pass
U.S. ARMY DUGWAY PROVING GROUND
DUGWAY VALLEY (5)
NEVADA
UTAH
Ibapah
GOSHUTE INDIAN RESERVATION
FISH SPRINGS FLAT (2)
2ND STANDARD PAR.
Callao
SNAKE VALLEY (16)
Ruins
FISH SPRINGS FLAT



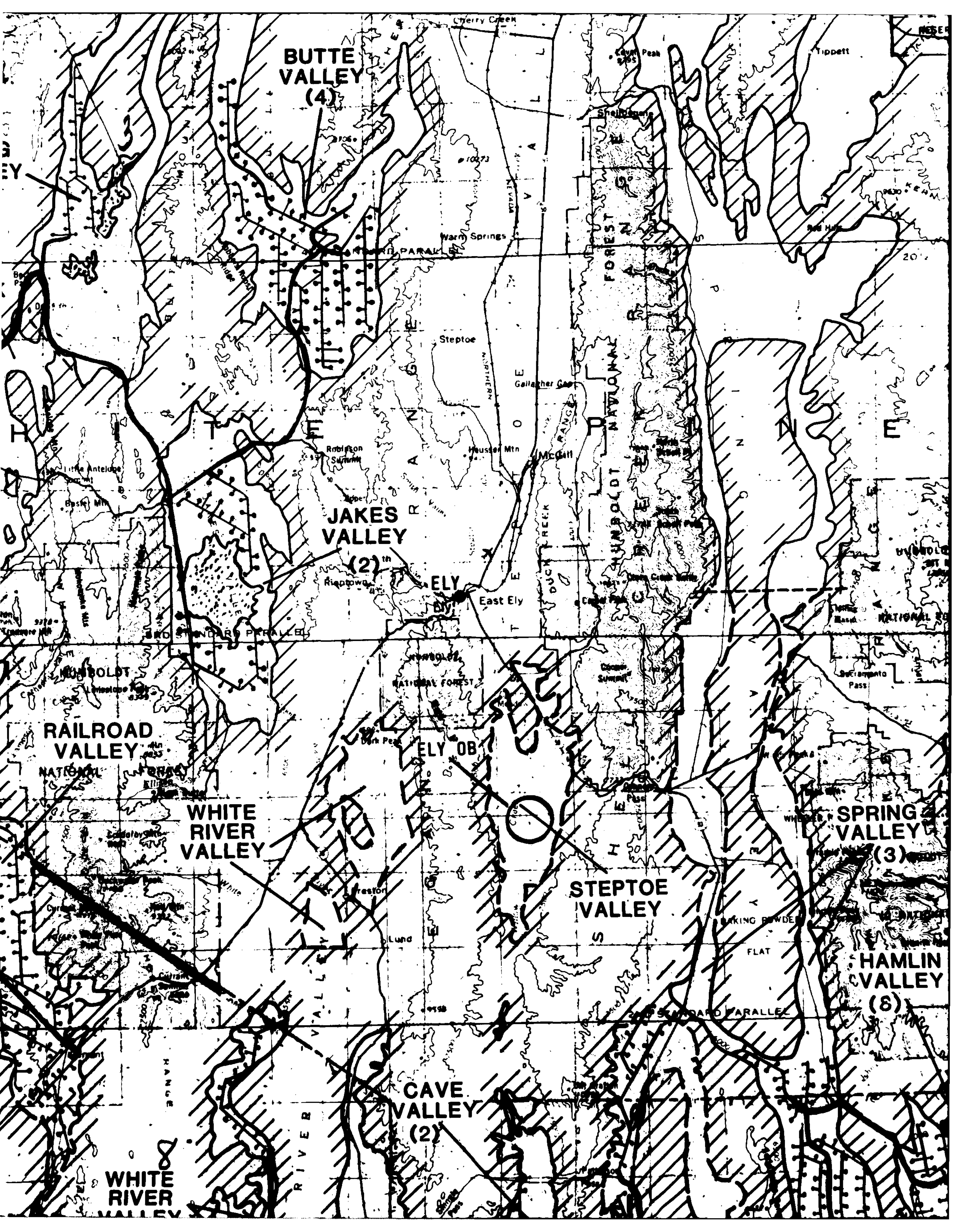
113°00'
Rowley
Stansbury Island
Mud Flat
PUDDLE
Delle
Timpie
TOOELE
Clive
Salt Flats
Dolomite
Flux
Burmester
Mills Junction
Lake Point Junction
SALT LAKE CITY
West Bountiful
Woods Cross
North Salt Lake
Saltair
Garfield
Magna
Redwood
Granger
Kearns
Bacchus
Erda
Marshall
Grantsville
VALLEY
MERIDIAN
WEST
SKULL
West Jordan
Midvale
Sandy
Copperton
South Jordan
International
Tooele
Lark
Herriman
Riverton
Bluffdale
Draper
Tod Park
Bauer
Stockton
TRAVERSE
L
E
Saint John Station
Saint John
Clover
American Fork
Saratoga Springs
Willow Springs
RUSH
Fairfield
Dugway
CEDAR
Faust
Vernon
Lookout Pass
Red Pine Mtn
GOSHEN
AY
EY
Lofgreen
SEVIER
DESERT
(4)
NATIONAL
40°00'
Goshen
Elberta
Tintic Junction
WEST TINTIC MOUNTAINS
EAST TINTIC MTS
Jericho
Black Mts
B
Pelican
Lincoln



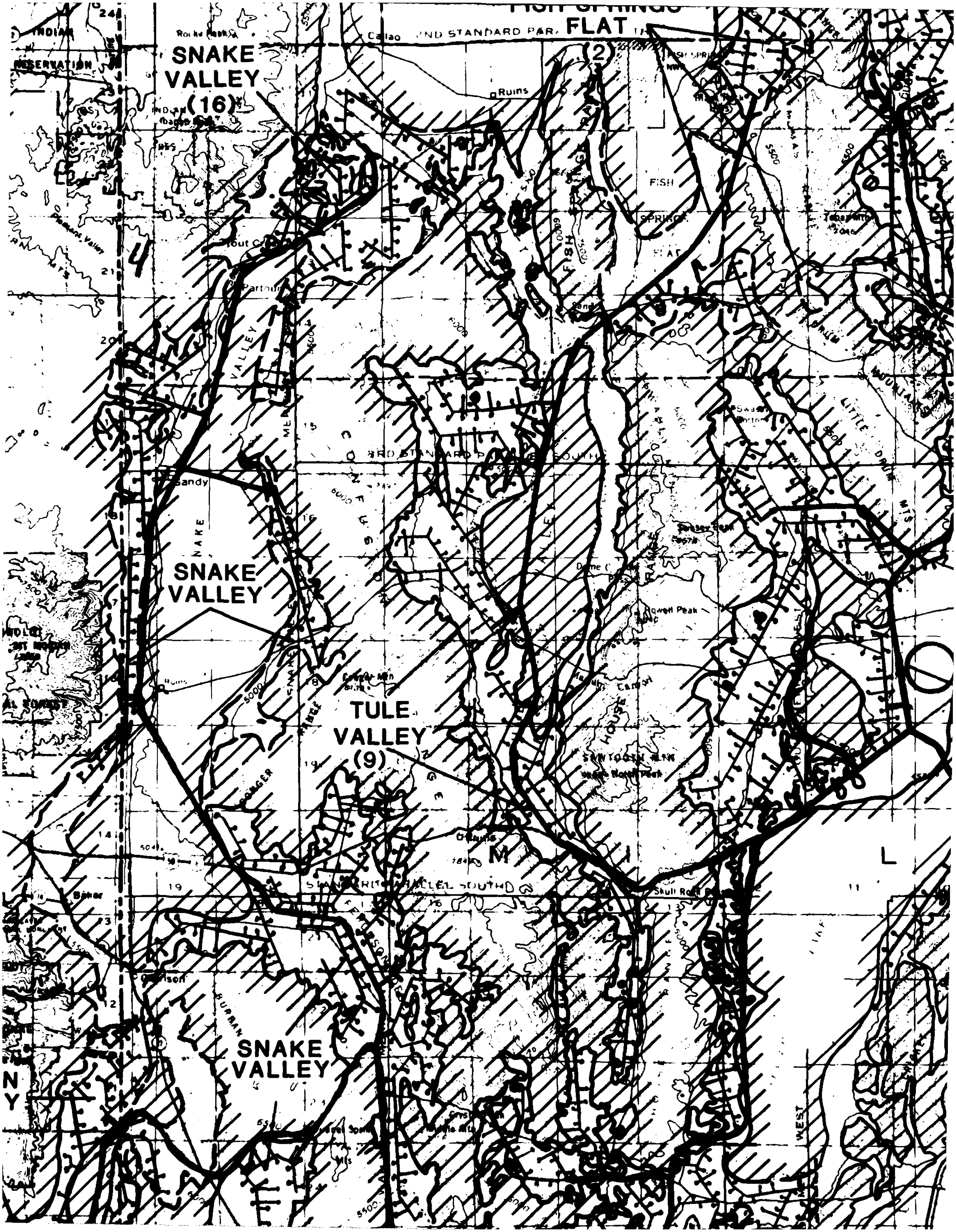
Dixie Valley
Round Mtn
Twin Peaks
Chalk Mtn
Eastgate
EDWARDS
CREEK
VALLEY
Railroad Pass
AUSTIN
MONI
VALI
(3
North Shoshone Peak
South Shoshone Peak
TOIYABE
NATIONAL
FOREST
39°00'
Gabbs
Alkali
Flat
Round Mountain
BIG SMOKY
VALLEY
(13)



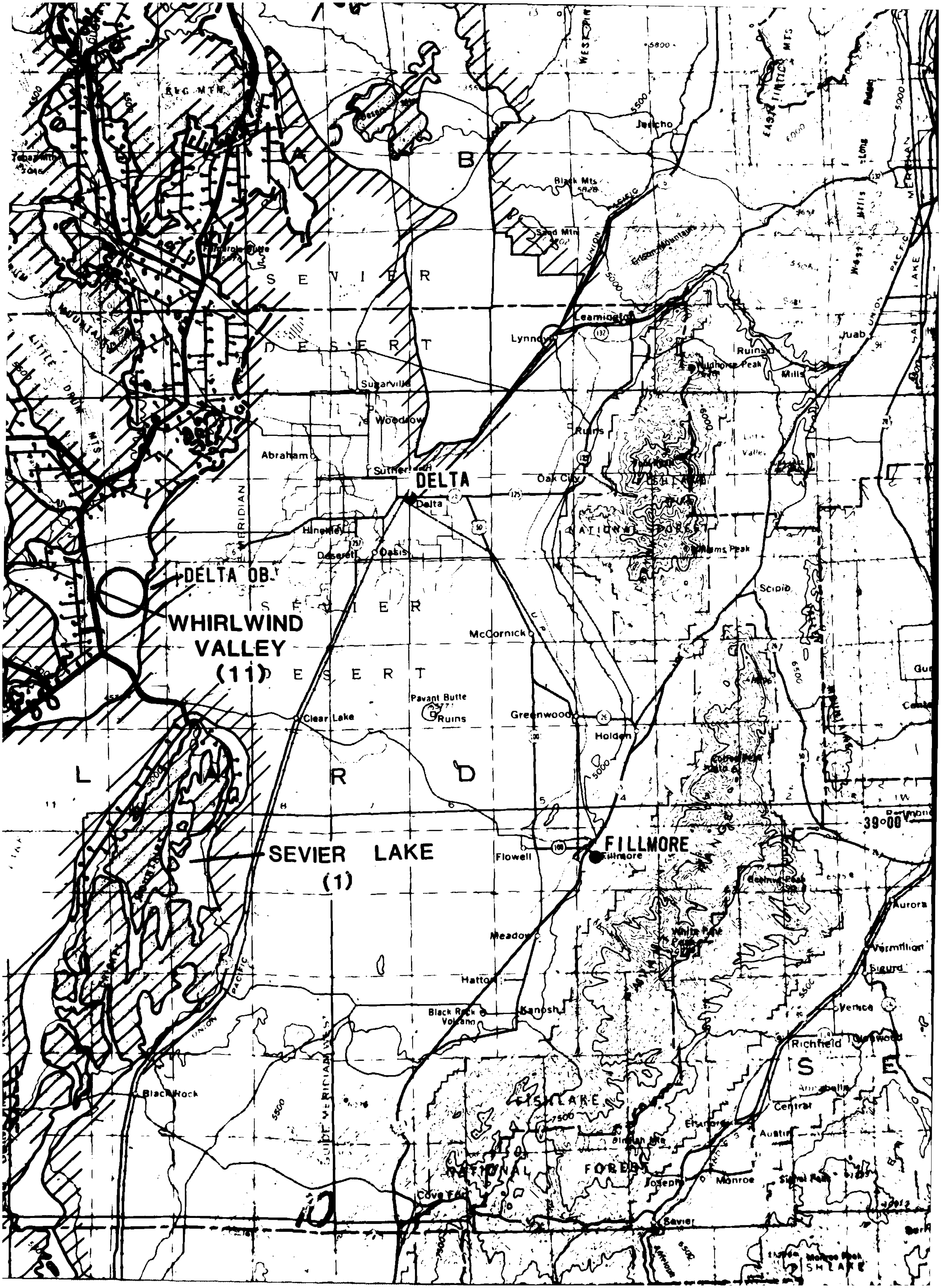
2
(6)
LONG VALLEY (1)
NEWARK VALLEY (1
EUREKA
ANTELOPE VALLEY (7)
ITOR
LEY
LITTLE SMOKY VALLEY (3)
BIG SAND SPRINGS VALLEY (3)
STONE CABIN VALLEY (7)
HOT CREEK VALLEY (4)

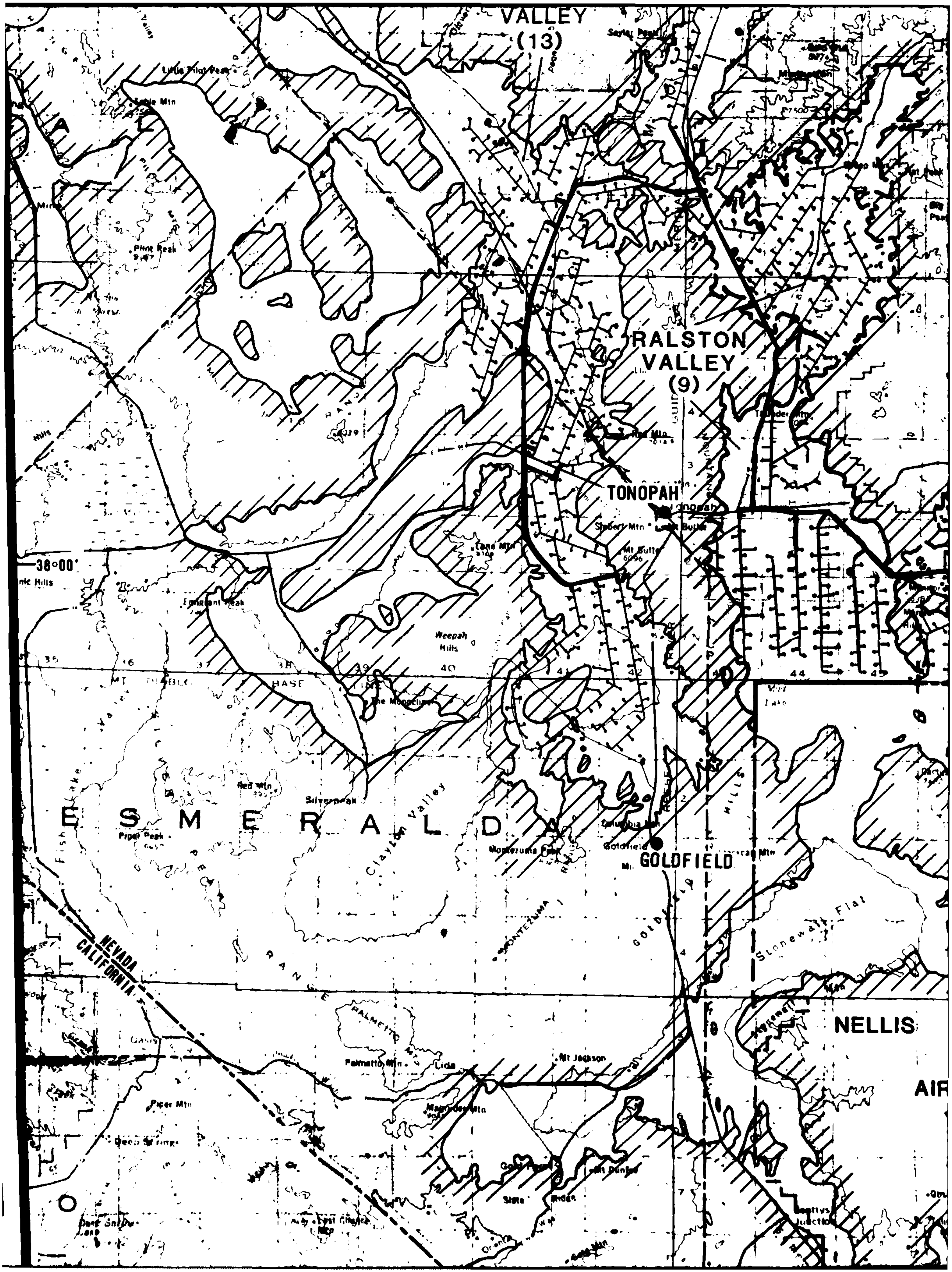


BUTTE VALLEY (4)
JAKES VALLEY (2)
ELY
East Ely
McGill
Steptoe
Warm Springs
Robinson Summit
Riepetown
RAILROAD VALLEY
WHITE RIVER VALLEY
ELY OB
STEPTOE VALLEY
SPRING VALLEY (3)
HAMLIN VALLEY (8)
CAVE VALLEY (2)
WHITE RIVER VALLEY
Preston
Lund
Cherry Creek
Tippett
Sacramento Pass
BAKING POWDER FLAT
HUMBOLDT NATIONAL FOREST

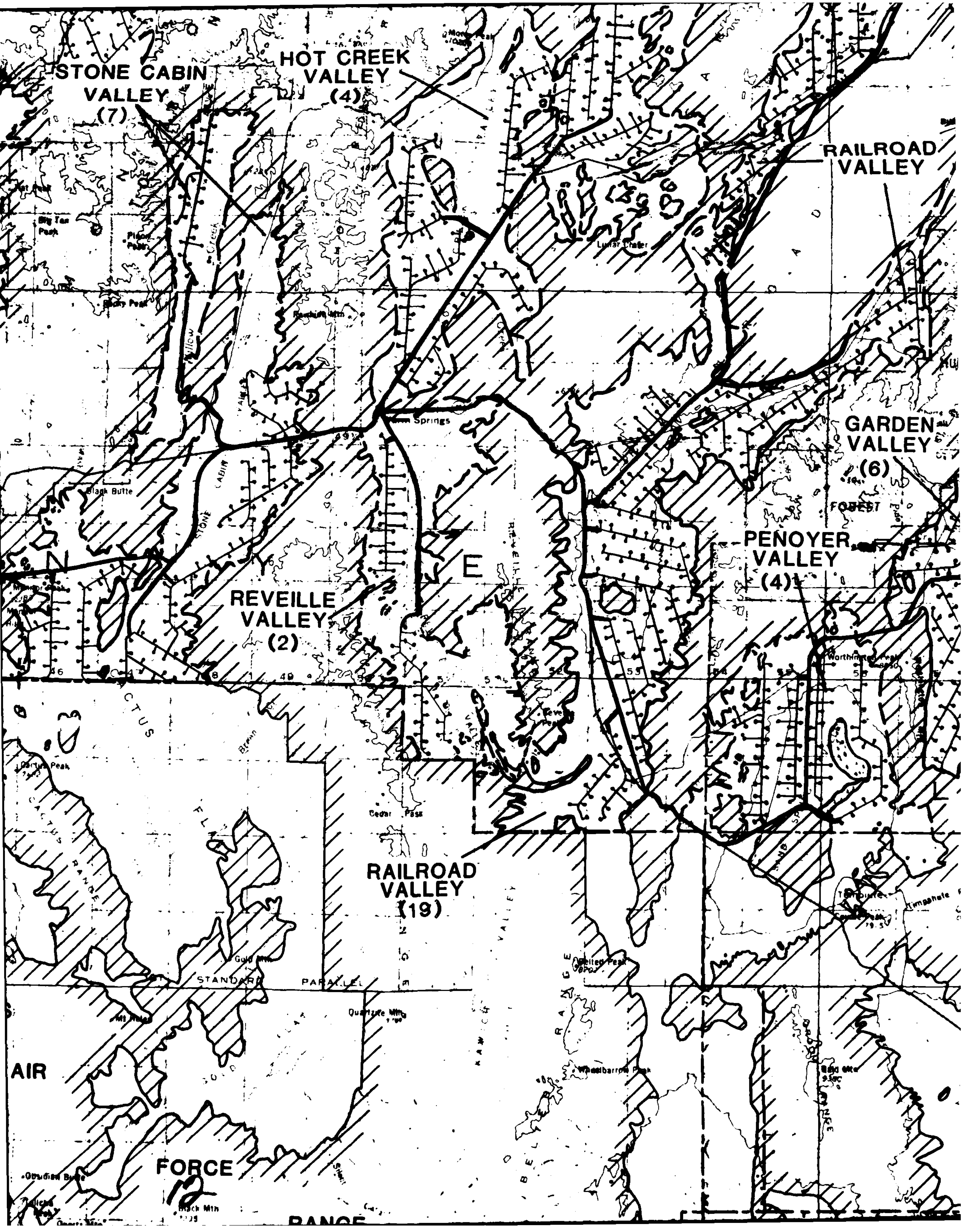


FISH SPRINGS FLAT
(2)
SNAKE VALLEY
(16)
INDIAN RESERVATION
2ND STANDARD PAR.
Callao
Ruins
FISH SPRINGS FLAT
Partoun
3RD STANDARD PARALLEL SOUTH
Sandy
SNAKE VALLEY
TULE VALLEY
(9)
Swasey Peak
Howell Peak
SAWTOOTH MTN
Baker
Garrison
SNAKE VALLEY
L
M
Skull Rock Pass
LITTLE DRUM MOUNTAINS
WEST

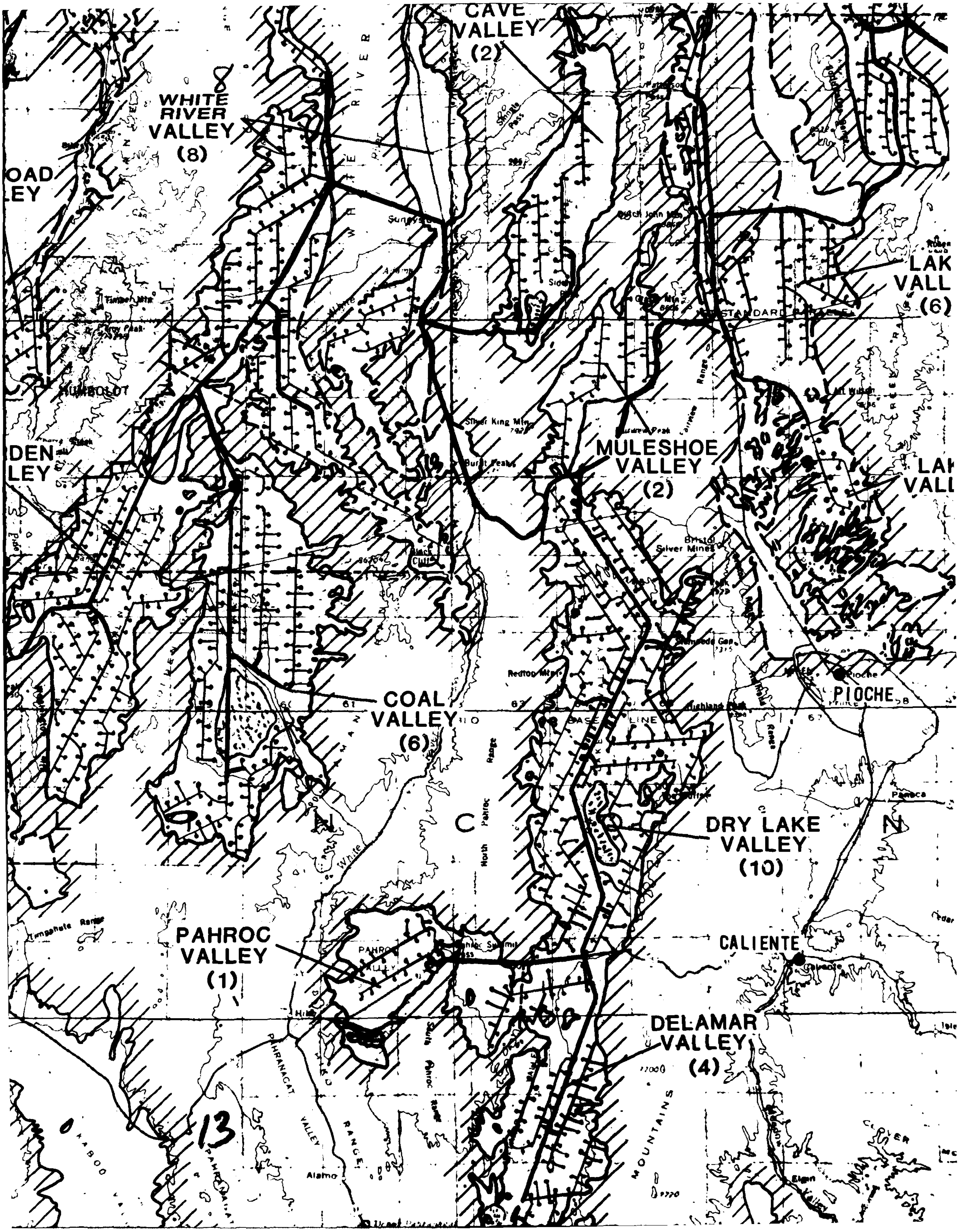

DELTA
DELTA OB.
WHIRLWIND
VALLEY
(11)
SEVIER LAKE
(1)
FILLMORE
SEVIER
DESERT
SEVIER
DESERT
Delta
Oak City
Leamington
Lynndyl
Sugarville
Woodrow
Abraham
Sutherland
Hinckley
Deseret
Oasis
McCornick
Greenwood
Holden
Scipio
Clear Lake
Pavant Butte
Ruins
Flowell
Fillmore
Meadow
Hatton
Kanosh
Black Rock Volcano
Black Rock
Cove Fort
Juab
Mills
Aurora
Vermillion
Sigurd
Venice
Richfield
Central
Austin
Joseph
Monroe
Sevier
Jericho
Black Mts
Sand Mtn
NATIONAL FOREST
FISHLAKE
NATIONAL
FOREST
UNION PACIFIC
39°00'

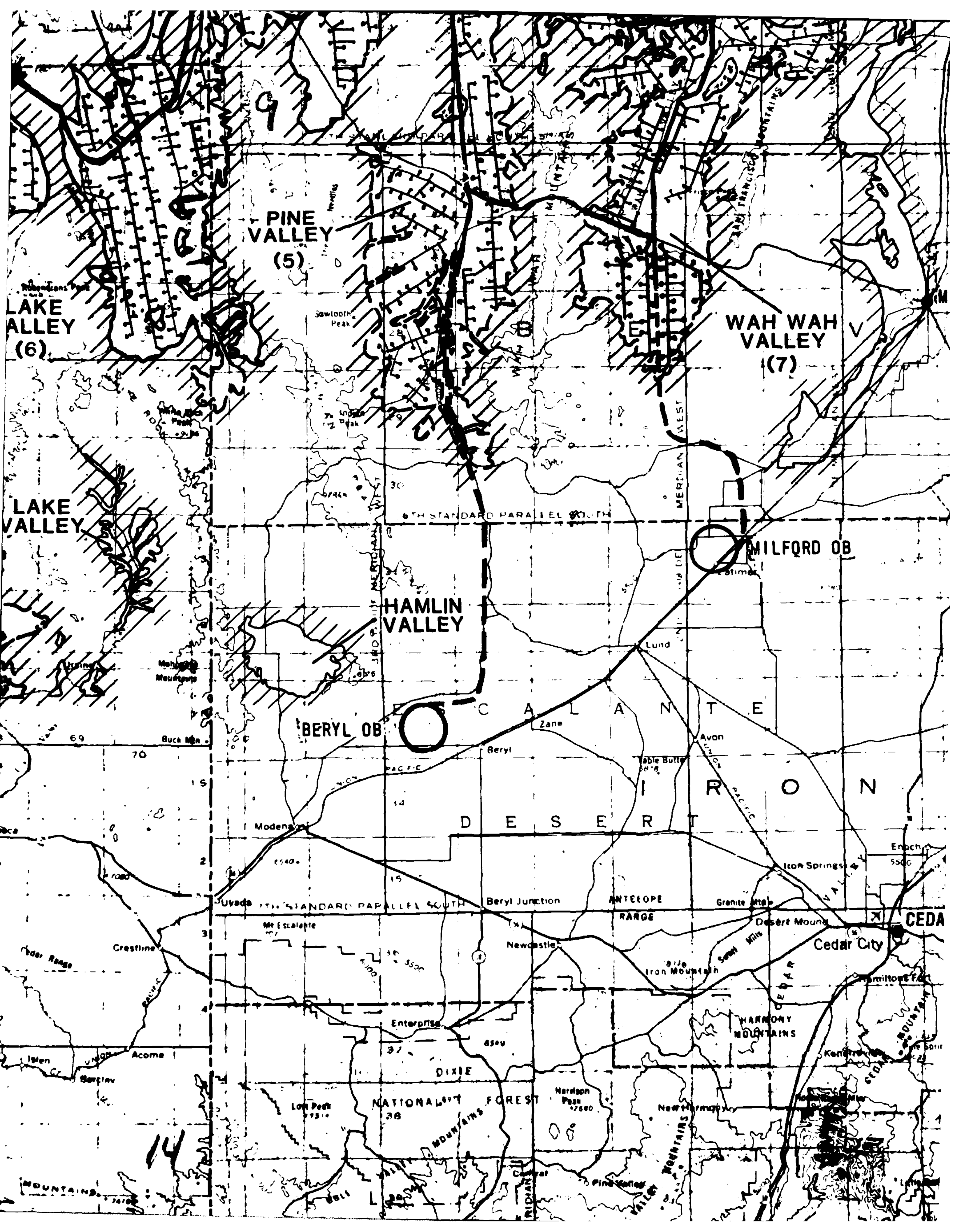


VALLEY
(13)
RALSTON
VALLEY
(9)
TONOPAH
GOLDFIELD
E S M E R A L D
NELLIS
AIR
NEVADA
CALIFORNIA
38°00'
Clayton Valley
Stonewall Flat
Weepah Hills
The Monocline
Silverpeak
Red Mtn
Piper Peak
Lone Mtn
Mt Butler
Siebert Mtn
Montezuma Peak
Columbia Mtn
Mt Jackson
Palmetto Mtn
Lida
Magruder Mtn
Piper Mtn
Gold Point
Slate Ridge
Little Pilot Peak
Pilot Peak
Emigrant Peak
Fish Lake Valley
Palmetto
Montezuma
Goldfield
Tonopah

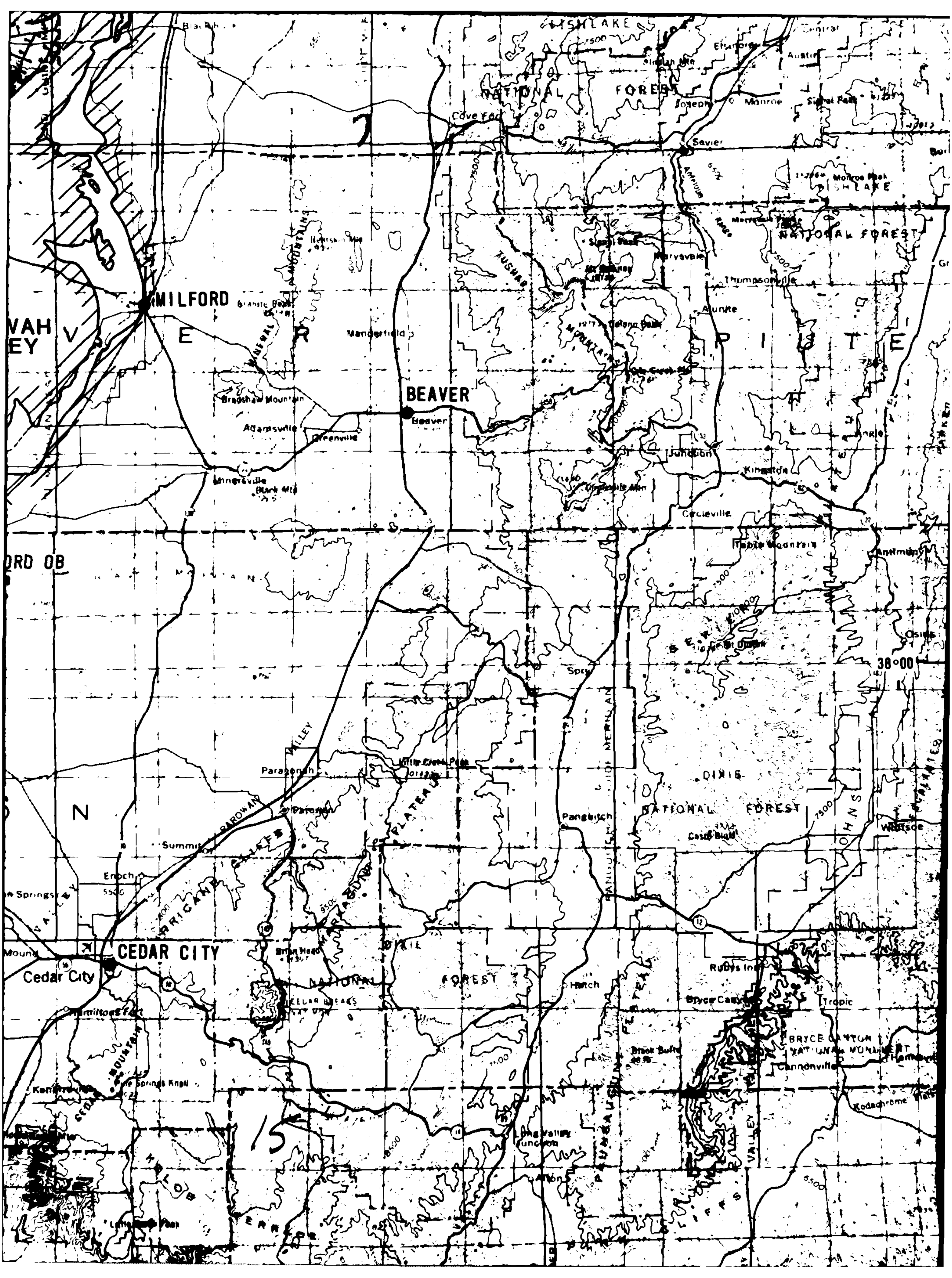


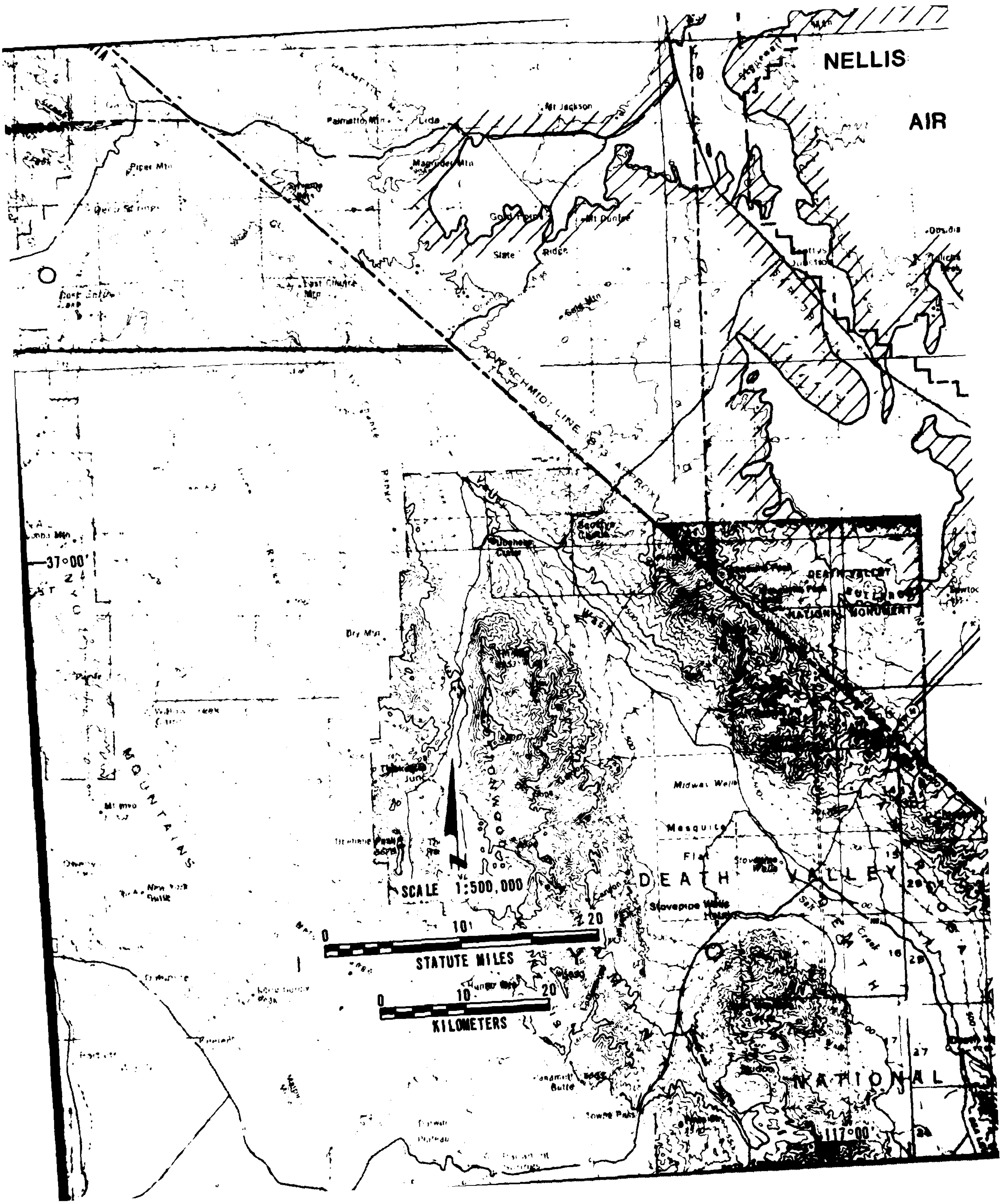
STONE CABIN VALLEY (7)
HOT CREEK VALLEY (4)
RAILROAD VALLEY
GARDEN VALLEY (6)
PENOYER VALLEY (4)
REVEILLE VALLEY (2)
RAILROAD VALLEY (19)
E
AIR
FORCE
RANGE
Lunar Crater
Black Butte
Cactus Peak
Cedar Pass
Gold Mtn
Quartzite Mtn
Wheelbarrow Peak
Worthington Peak
STANDARD PARALLEL
FOREST

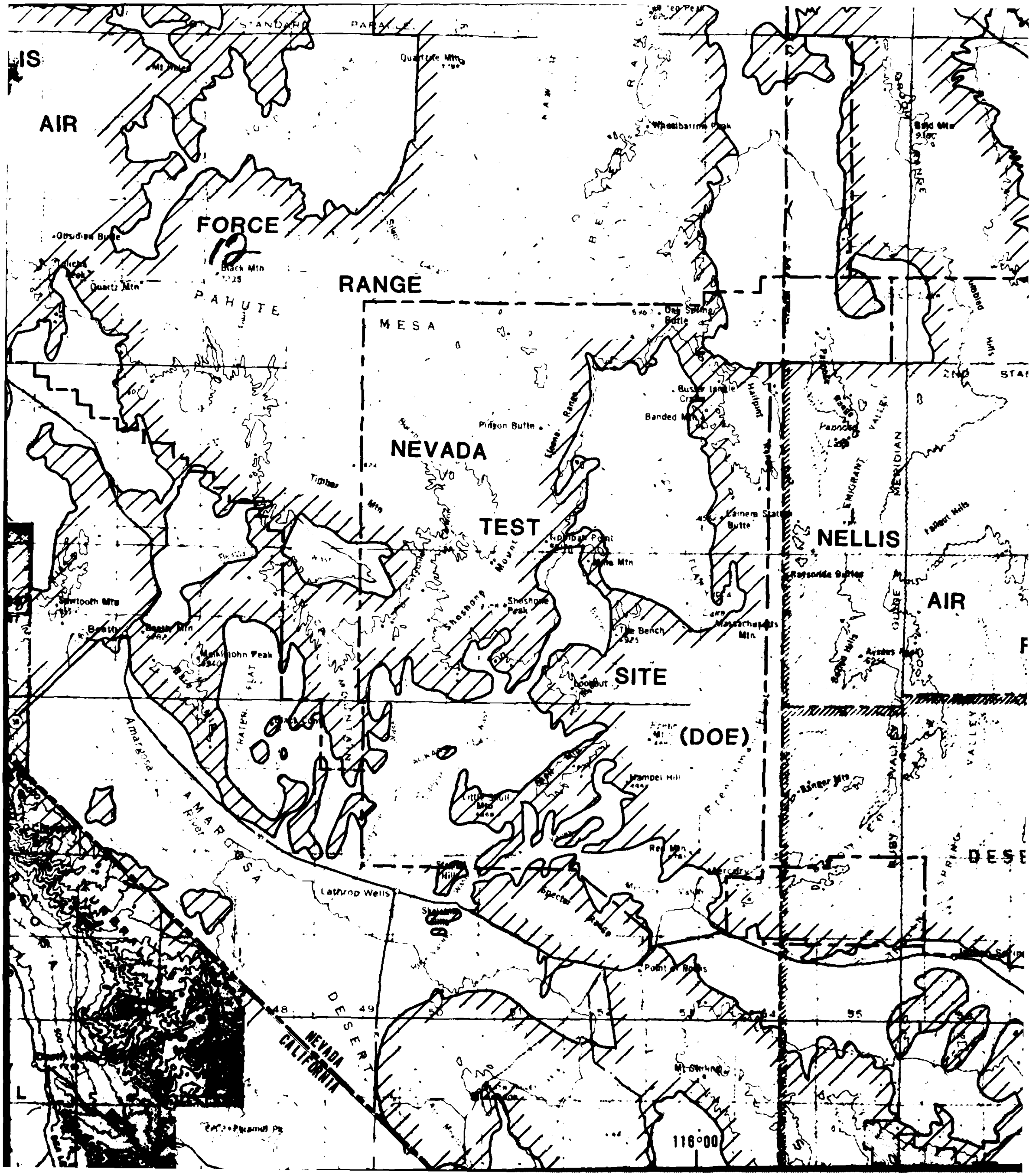

CAVE VALLEY (2)
WHITE RIVER VALLEY (8)
8
MULESHOE VALLEY (2)
COAL VALLEY (6)
PIOCHE
DRY LAKE VALLEY (10)
PAHROC VALLEY (1)
CALIENTE
DELAMAR VALLEY (4)
13



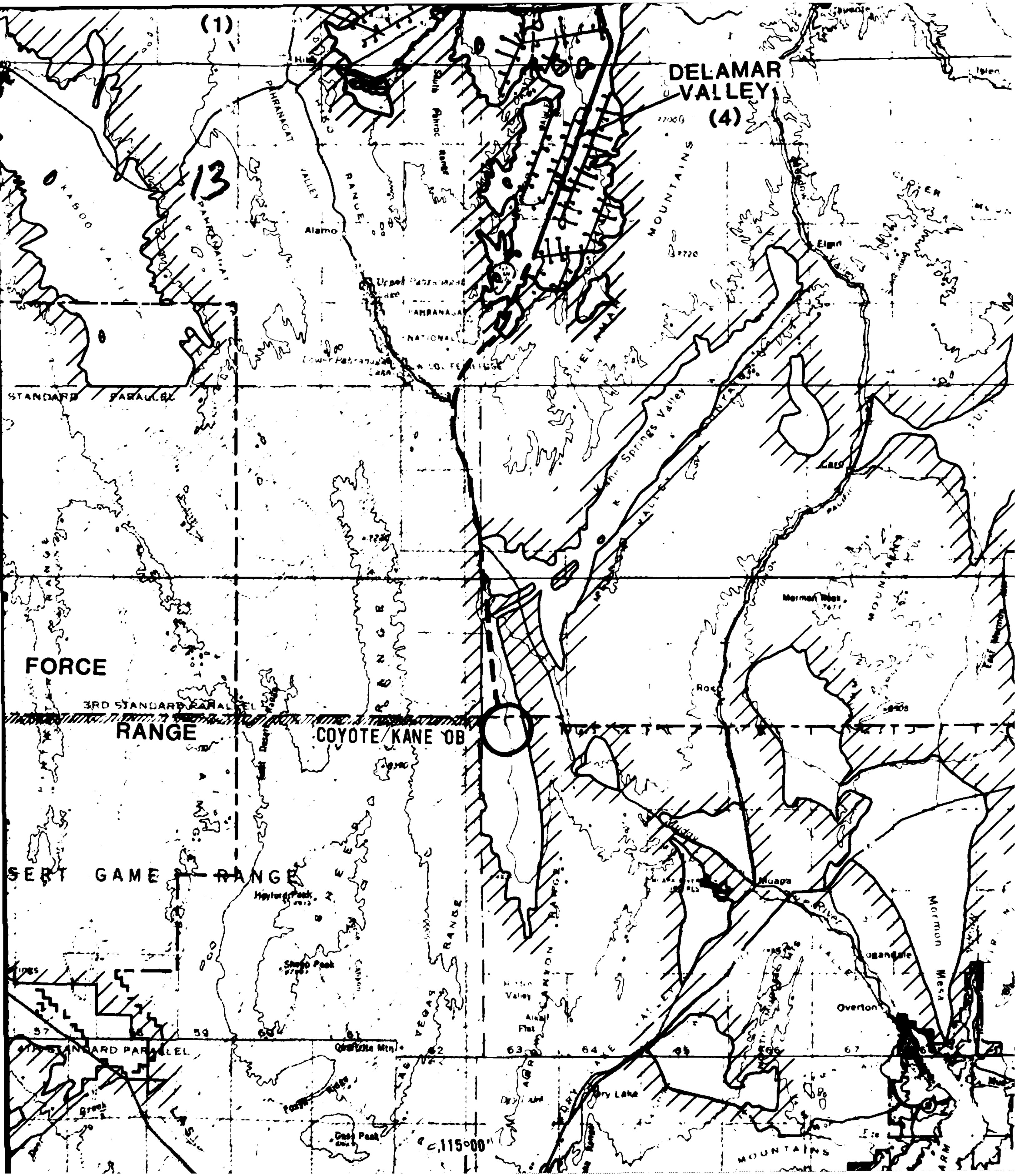
PINE VALLEY (5)
LAKE VALLEY (6)
LAKE VALLEY
WAH WAH VALLEY (7)
HAMLIN VALLEY
BERYL OB
MILFORD OB
6TH STANDARD PARALLEL SOUTH
7TH STANDARD PARALLEL SOUTH
ESCALANTE
IRON
DESERT
Sawtooth Peak
Lund
Zane
Beryl
Avon
Table Butte
Modena
Uvada
Beryl Junction
ANTELOPE RANGE
Granite Mtn
Iron Springs
Enoch
Desert Mound
Cedar City
CEDA
Newcastle
Iron Mountain
Crestline
Mt Escalante
Enterprise
HARMONY MOUNTAINS
DIXIE NATIONAL FOREST
Lost Peak
Hardscn Peak
New Harmony
Acoma
Buck Mtn
Latimer
Cedar Range
Pine Valley
Central
9
14


MILFORD
Manderfield
Bradshaw Mountain
Adamsville
Greenville
BEAVER
Beaver
Minersville
Cove Fort
NATIONAL FOREST
Sevier
Joseph
Monroe
Elsinore
Austin
Marysvale
Thompsonville
Alunite
Junction
Kingston
Circleville
Table Mountain
Antimony
Osiris
38°00'
Spry
Paragonah
Parowan
Summit
Enoch
CEDAR CITY
Cedar City
Panguitch
DIXIE
NATIONAL FOREST
Widtsoe
Rubys Inn
Tropic
BRYCE CANYON NATIONAL MONUMENT
Cannonville
Hatch
Long Valley Junction
Alton
CEDAR BREAKS
15

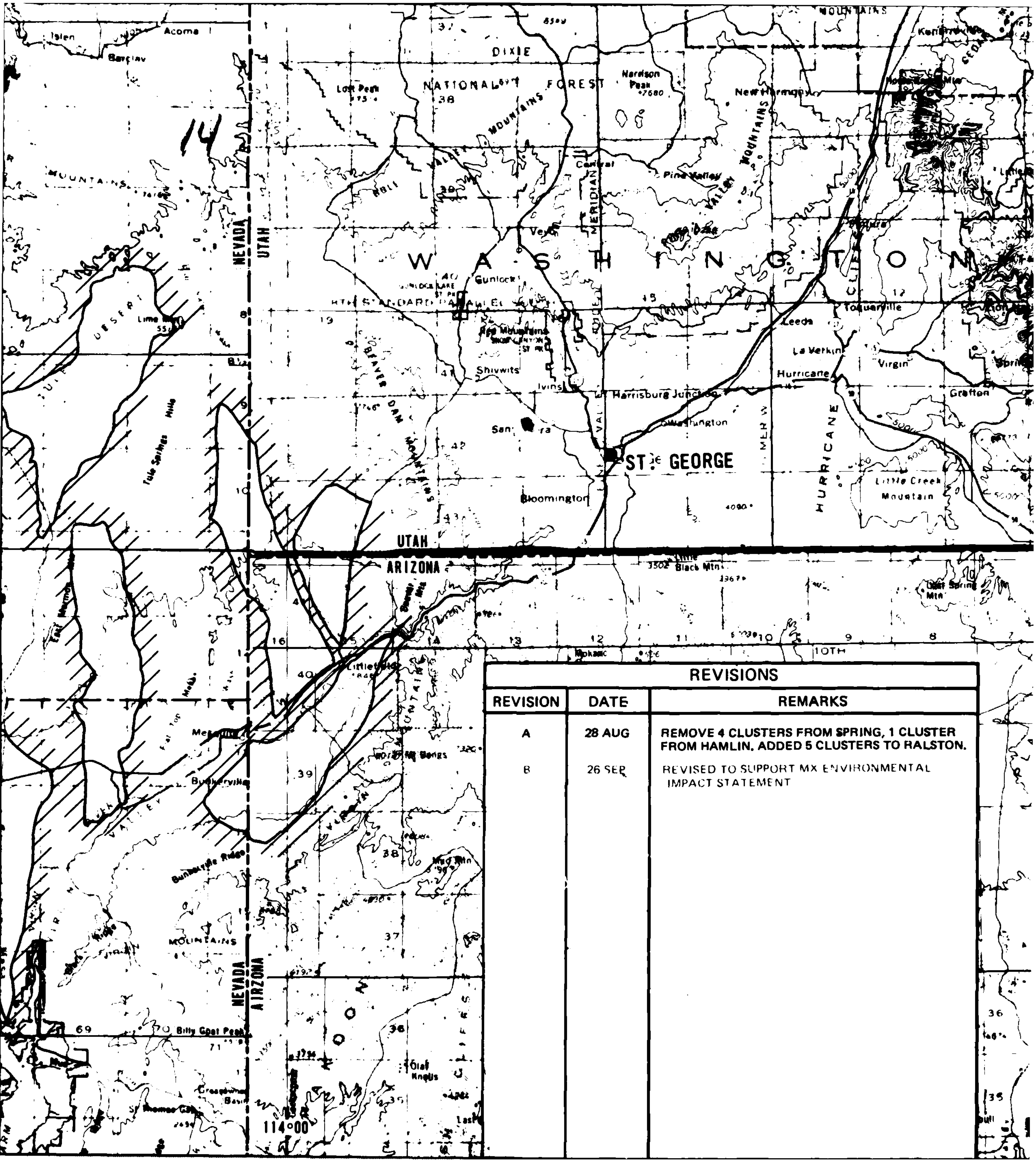

NELLIS
AIR
Mt Jackson
Palmetto Mtn
Lida
Magruder Mtn
Piper Mtn
Gold Point
Mt Dunfee
Slate
Ridge
East Chance Mtn
Gold Mtn
VON SCHMIDT LINE
APPROX.
DEATH VALLEY
NATIONAL MONUMENT
37°00'
Ubehebe Crater
Dry Mtn
Midway Wells
Mesquite
Flat
Stovepipe Wells
MOUNTAINS
SCALE 1:500,000
0
10
20
STATUTE MILES
KILOMETERS
DEATH
VALLEY
NATIONAL
Towne Pass
117°00'
Mt Inyo
Obsidian



AIR
FORCE
RANGE
PAHUTE
MESA
NEVADA
TEST
SITE
(DOE)
NELLIS
AIR
Black Mtn
Quartz Mtn
Obsidian Butte
Quartzite Mtn
Wheelbarrow Peak
Oak Spring Butte
Pinyon Butte
Timber Mtn
Banded Mtn
Shoshone Peak
Beatty
Bare Mtn
Sawtooth Mtn
Meiklejohn Peak
The Bench
Lookout
Massachusetts Mtn
Yucca
Frenchman Flat
Mercury
Red Mtn
Little Skull Mtn
Lathrop Wells
Specter Range
Point of Rocks
Amargosa River
AMARGOSA DESERT
NEVADA
CALIFORNIA
EMIGRANT VALLEY
MERIDIAN
Papoose Lake
Mt Stirling
Ranger Mtn
Halfpint Range
Ayers Peak
116°00'
48
49
50
54
55
DESE

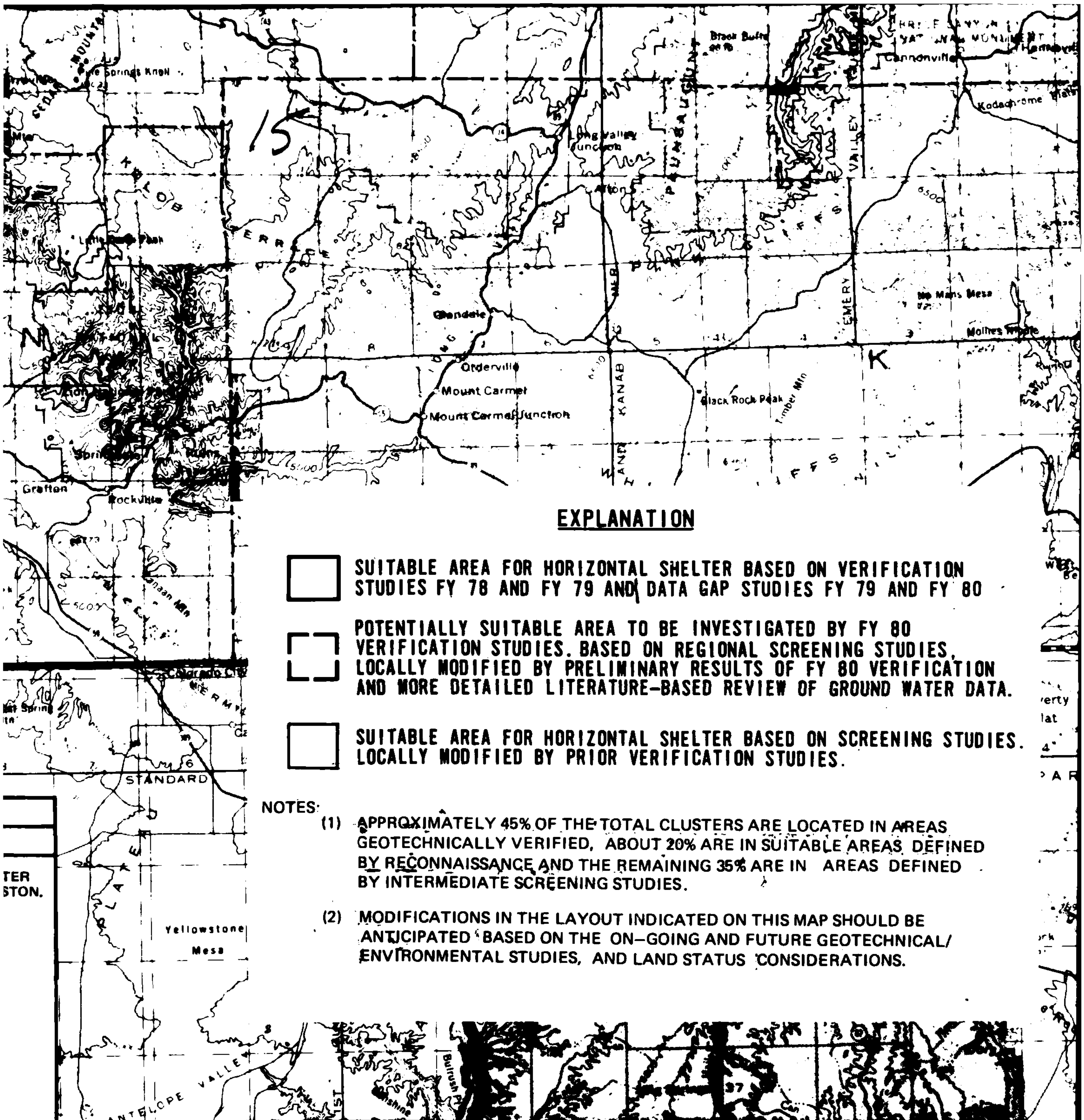


(1)
DELAMAR
VALLEY
(4)
13
PAHRANAGAT VALLEY
Alamo
MOUNTAINS
Kane Springs Valley
STANDARD PARALLEL
FORCE
3RD STANDARD PARALLEL
RANGE
COYOTE/KANE OB
Mormon Peak
Elgin
Moapa
Logandale
Overton
Mormon Mesa
SERT GAME RANGE
Hayford Peak
Sheep Peak
Gass Peak
Dry Lake
4TH STANDARD PARALLEL
57
59
60
61
62
63
64
65
66
67
115°00'
MOUNTAINS



REVISIONS

REVISION	DATE	REMARKS
A	28 AUG	REMOVE 4 CLUSTERS FROM SPRING, 1 CLUSTER FROM HAMLIN. ADDED 5 CLUSTERS TO RALSTON.
B	26 SEP	REVISED TO SUPPORT MX ENVIRONMENTAL IMPACT STATEMENT



EXPLANATION

SUITABLE AREA FOR HORIZONTAL SHELTER BASED ON VERIFICATION STUDIES FY 78 AND FY 79 AND DATA GAP STUDIES FY 79 AND FY 80

POTENTIALLY SUITABLE AREA TO BE INVESTIGATED BY FY 80 VERIFICATION STUDIES. BASED ON REGIONAL SCREENING STUDIES, LOCALLY MODIFIED BY PRELIMINARY RESULTS OF FY 80 VERIFICATION AND MORE DETAILED LITERATURE-BASED REVIEW OF GROUND WATER DATA.

SUITABLE AREA FOR HORIZONTAL SHELTER BASED ON SCREENING STUDIES. LOCALLY MODIFIED BY PRIOR VERIFICATION STUDIES.

NOTES:

(1) APPROXIMATELY 45% OF THE TOTAL CLUSTERS ARE LOCATED IN AREAS GEOTECHNICALLY VERIFIED, ABOUT 20% ARE IN SUITABLE AREAS DEFINED BY RECONNAISSANCE AND THE REMAINING 35% ARE IN AREAS DEFINED BY INTERMEDIATE SCREENING STUDIES.

(2) MODIFICATIONS IN THE LAYOUT INDICATED ON THIS MAP SHOULD BE ANTICIPATED BASED ON THE ON-GOING AND FUTURE GEOTECHNICAL/ENVIRONMENTAL STUDIES, AND LAND STATUS CONSIDERATIONS.

1	1 JUL 80
2	17 JUL 80
3	2 SEP 80
4	26 SEP 80
5	
6	
7	

5200-FOOT 2/3 FILLED HEXAGONAL LINEAR MPS REGIONAL LAYOUT

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

DRAWING 6-1

FUGRO NATIONAL, INC.

7.0 FIELD SURVEYS, IOC VALLEYS

7.1 OBJECTIVES

The objectives of the field surveys in the IOC valleys are to develop a methodology and identify problems associated with locating shelters in the Nevada-Utah siting area. Potential problems can be either geotechnical, cultural, or environmental, and if a problem is identified, the study will help in identifying the extent of the problem and possible solutions. In particular, it is important to know how many sites will have to be relocated and by how much. When sites are relocated, is there adequate space and will the layout criteria be violated? These studies will help to determine if any changes are needed in the present layout criteria or procedures.

The term "IOC valleys" has been included in the definition of the program because the valleys that have been selected for the study are likely to be the valleys where construction of the MX system would start. The shelters constructed in the valleys would be the ones used for the Initial Operational Capability (IOC) of MX. The valleys selected for the study are: Dry Lake Valley, Nevada, and Pine and Wah Wah valleys, Utah (Figure 7-1). The valleys are close to the respective candidate OB sites at Coyote Spring, Nevada, and Beryl and Milford sites, Utah.

7.2 SCOPE

The elements of the study are as follows:

- Complete shelter layouts for the three valleys at a scale of 1:62,500, showing all shelter, CMF, and RSS locations. The layouts are included in pockets at the end of the section and

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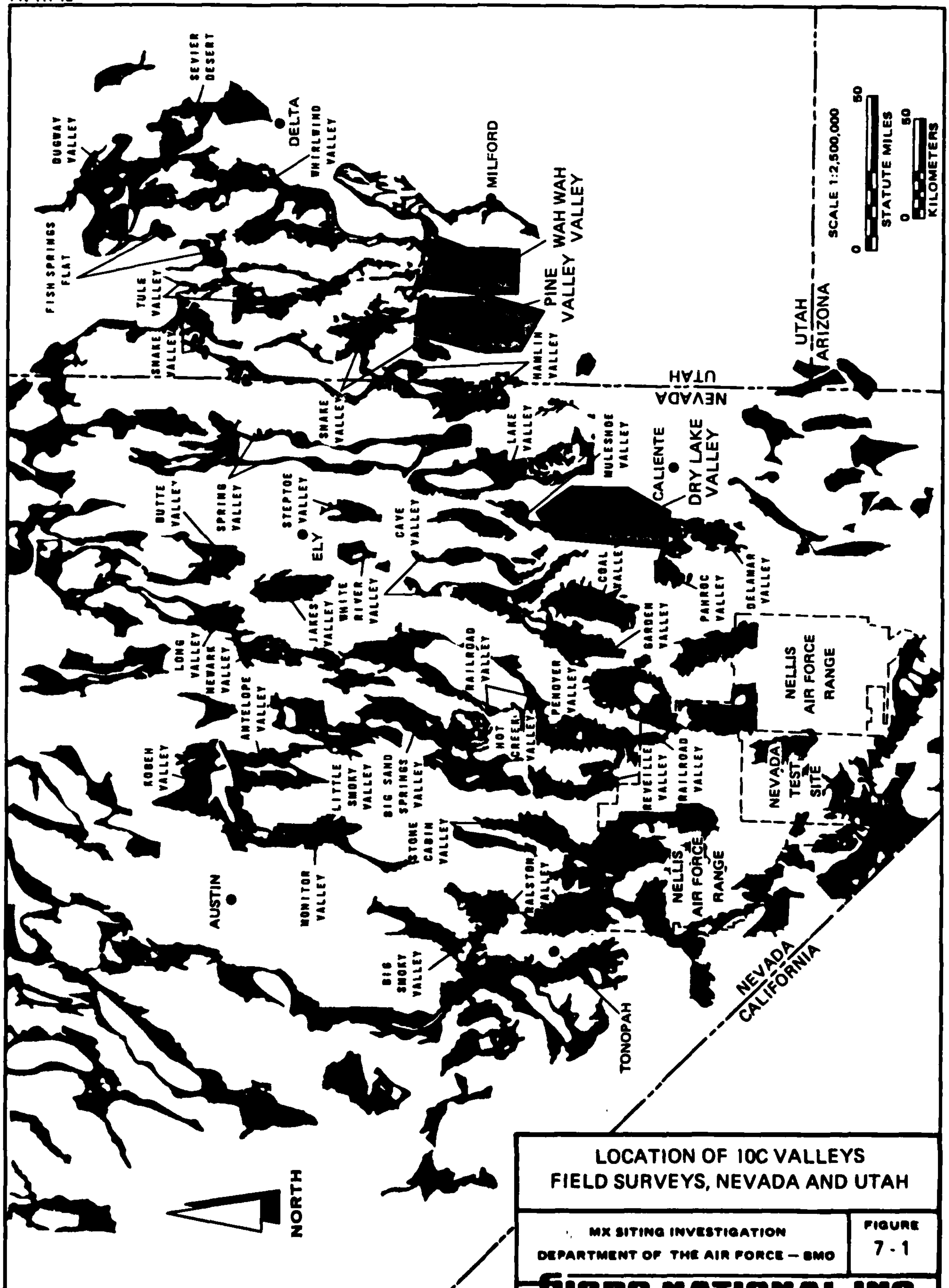


LOCATION OF 10C VALLEYS
FIELD SURVEYS, NEVADA AND UTAH

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE — BMO

FIGURE
7-1

FUGRO NATIONAL, INC.

26 NOV 80

show ten clusters in Dry Lake Valley (Version 8A, Drawing 7-1) and five clusters each in Pine (Version 1, Drawing 7-2) and Wah Wah (Version 2, Drawing 7-3) valleys.

- Submit the layouts to the BMO/AFRCE for review. Modify the layouts, if needed, in accordance with review comments.
- After review and approval of the drawing, transfer the layouts to 1:9600 (1"=800'; 1 cm=96 m) topographic sheets with 10-foot (3 m) contours. Adjustments to the site locations may be necessary to avoid drainages or other geotechnical considerations that can be identified at this larger scale.
- Determine the state plane coordinates and bearings of all structures and provide this information to the field survey teams. Also determine the coordinates of points of intersection of the DTN and roads in Cluster 2, Dry Lake Valley.
- The field survey teams locate each structure and place monuments to identify the sites. The DTN route and Cluster 2 roads in Dry Lake Valley will also be staked.
- Environmental and geotechnical teams inspect each site and staked roads to determine if they are acceptable. If there are problems, the shelters are relocated and the coordinates of the new locations are determined.
- Legal descriptions are prepared for each shelter, CMF, and RSS site.
- An environmental report and a general report of the program are prepared.

7.3. METHODOLOGY

The procedures used in preparing layouts at a scale of 1:62,500 were previously explained in Section 6.0. The methodology in this section explains the procedures after the 1:62,500 layouts have been completed and approved by the BMO/AFRCE. The process is as follows:

- The layouts are transferred to topographic sheets having a scale of 1:9600 with 10-foot contours. During the transfer process, shelter locations are adjusted to avoid geotechnical, cultural, or environmental problems.
- After all adjustments have been made to the locations of shelters, CMFs, and RSSs, reference points are digitized

for each structure. The reference point for a shelter is the intersection of the centerline with the outside edge of the door opening.

- o The digital data are fed into a computer program and the print-out consists of state plane coordinates of the reference points and the bearing of the structures. The program also prints out the distance to neighboring shelters to provide a check on the spacing criteria.

- o The coordinate and bearing data are given to the surveyors who input them into their own computer programs to provide the information they need to locate the structures in the field.

- o The field procedures are explained by the flow chart (Figure 7-2). As shown by the chart, if a shelter has to be relocated, it must be resurveyed and inspected.

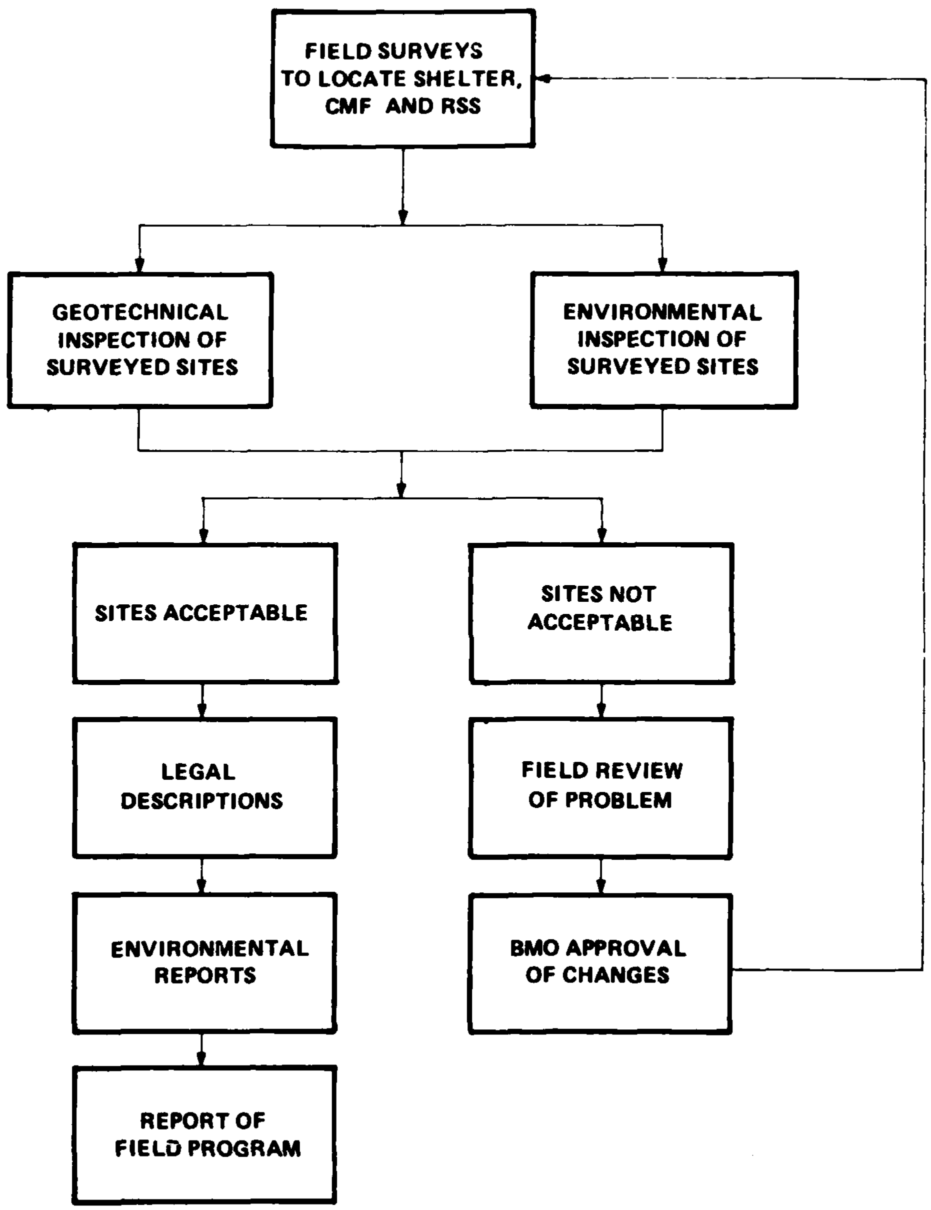
- o Each site is identified by monuments consisting of 4-inch (10-cm) diameter caps attached to 3/4-inch (1.9-cm) rebars. Shelters are identified by three monuments (Figure 7-3) and CMFs are located by six monuments (Figure 7-4). RSS sites are identified by six monuments with the same configuration as CMFs except the site area is 100 feet by 100 feet (30 m by 30 m).

- o The environmental survey area for shelters consists of over 12 acres (4.9 hectares; ha) and the dimensions are shown in Figure 7-5. The survey area for CMFs and RSSs consists of nearly 20 acres (8 ha) (Figure 7-4) and 6 acres (2.5 ha), respectively.

7.4 SCHEDULE

The work started in Dry Lake Valley and key dates are as follows:

- o Mobilization of survey teams - 28 August;
- o Opening of field office in Caliente - 29 September;
- o Mobilization of environmental teams - 29 September;
- o Completion of field surveys - 6 November;
- o Field review of progress - 12 November;
- o Completion of environmental inspections - 18 November;
- o Completion of geotechnical inspections - 3 December (estimated); and

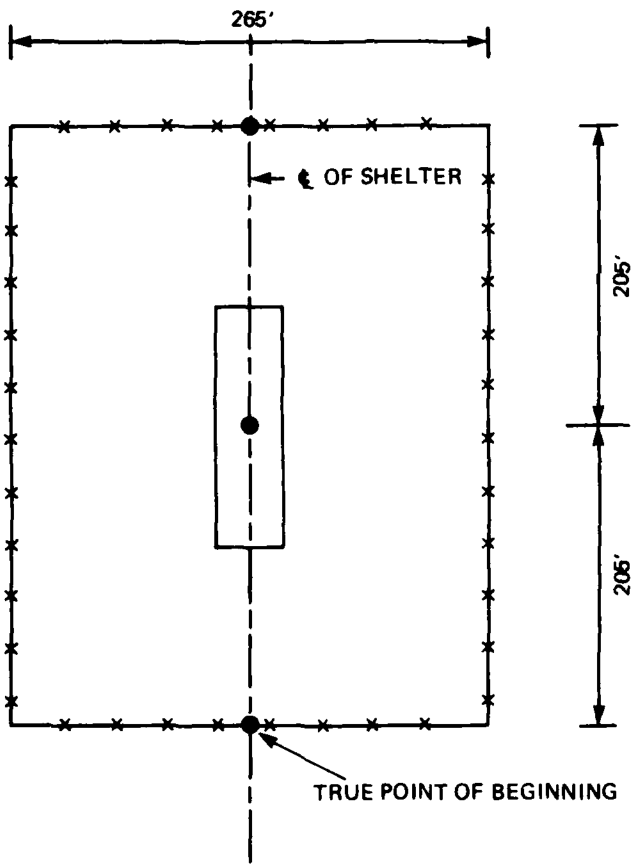


FIELD PROCEDURES
DRY LAKE, PINE, AND WAH WAH VALLEYS

MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE — BMO	FIGURE 7 - 2

FUGRO NATIONAL, INC.

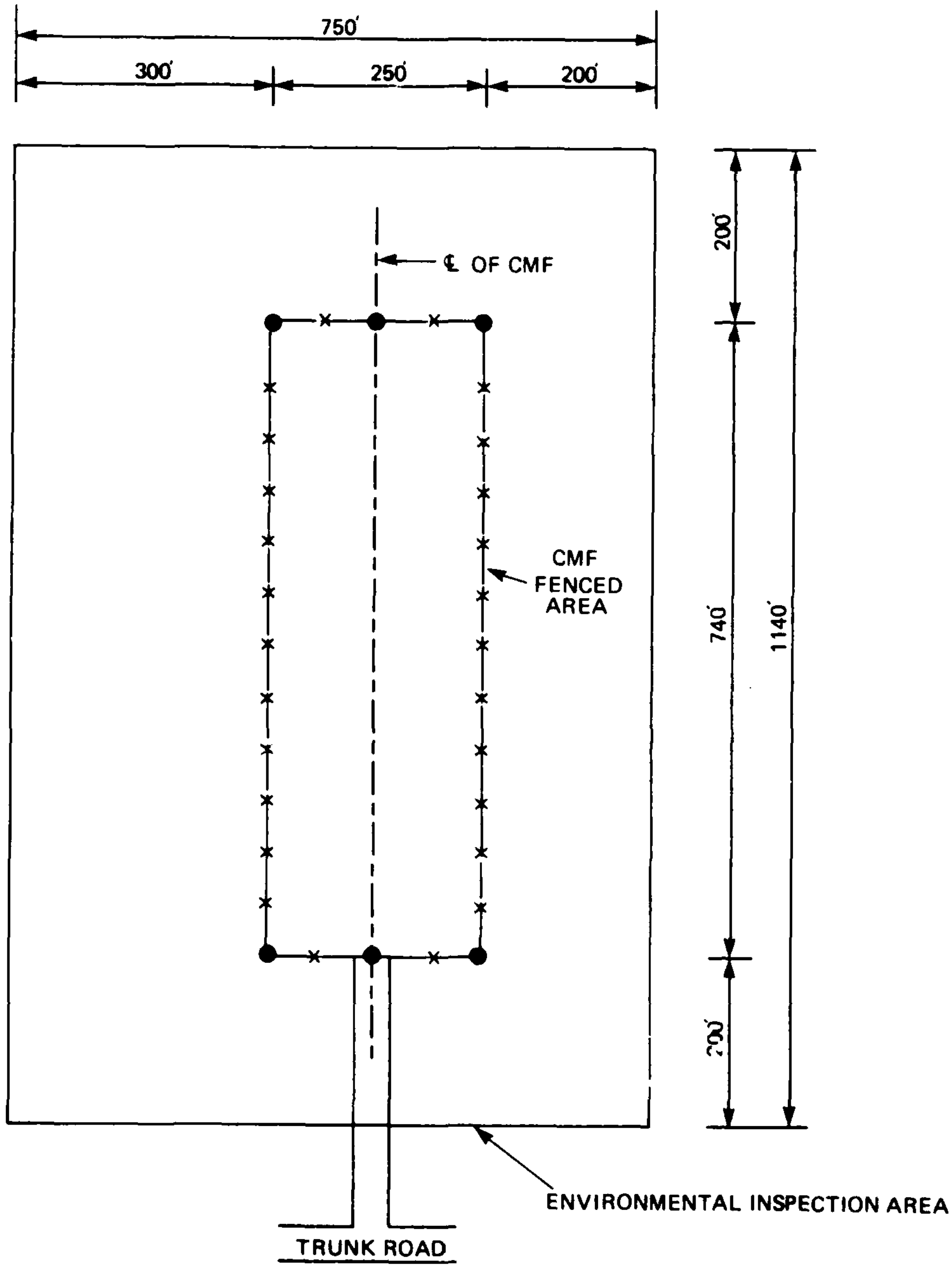
LOCATION OF SURVEY MONUMENTS AT SHELTER SITES, IOC VALLEYS



● POINTS WHERE SURVEY MONUMENTS WILL BE LOCATED

LOCATION OF SURVEY MONUMENTS AT SHELTER SITES, IOC VALLEYS	
MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE BMO	FIGURE 7-3
FUGRO NATIONAL, INC.	

FN-TR-42



ENVIRONMENTAL INSPECTION AREA
AT CMF SITES, IOC VALLEYS

MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE - BMO	FIGURE 7-4

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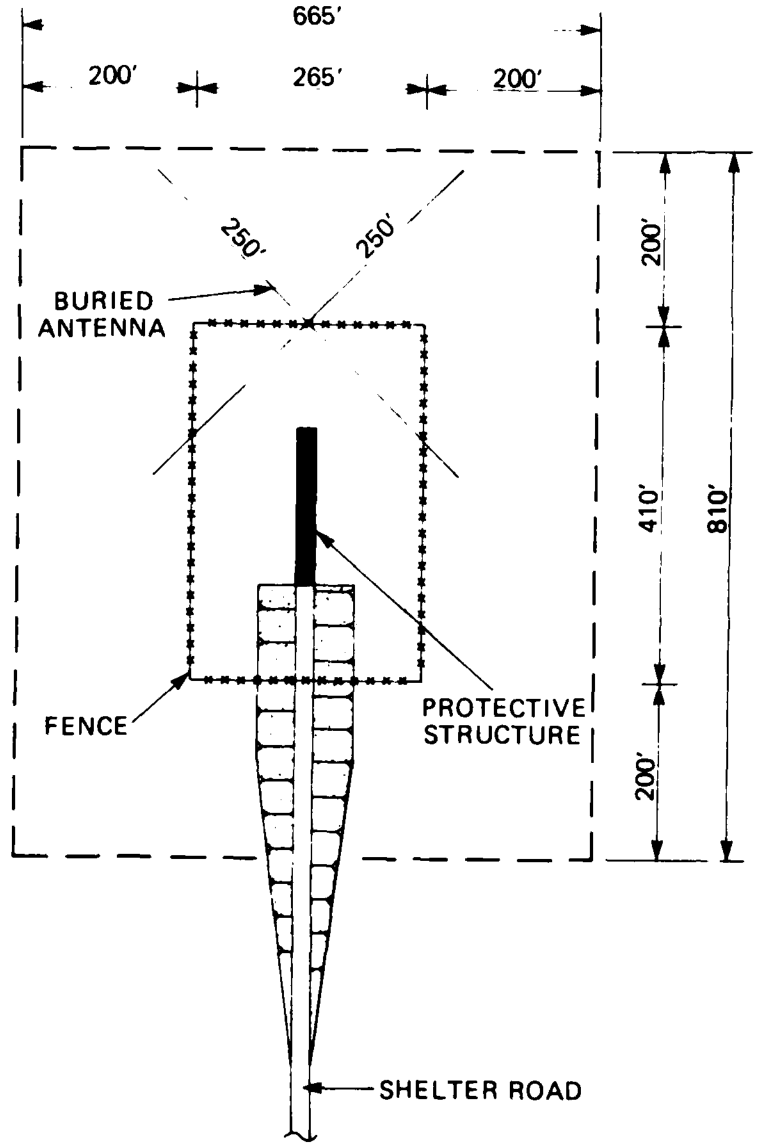
26 NOV 80



ENVIRONMENTAL INSPECTION
AREA AT SHELTER SITE

MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE – BMO	FIGURE 7-5

FUGRO NATIONAL, INC.

o Completion of resiting - 13 December (estimated).

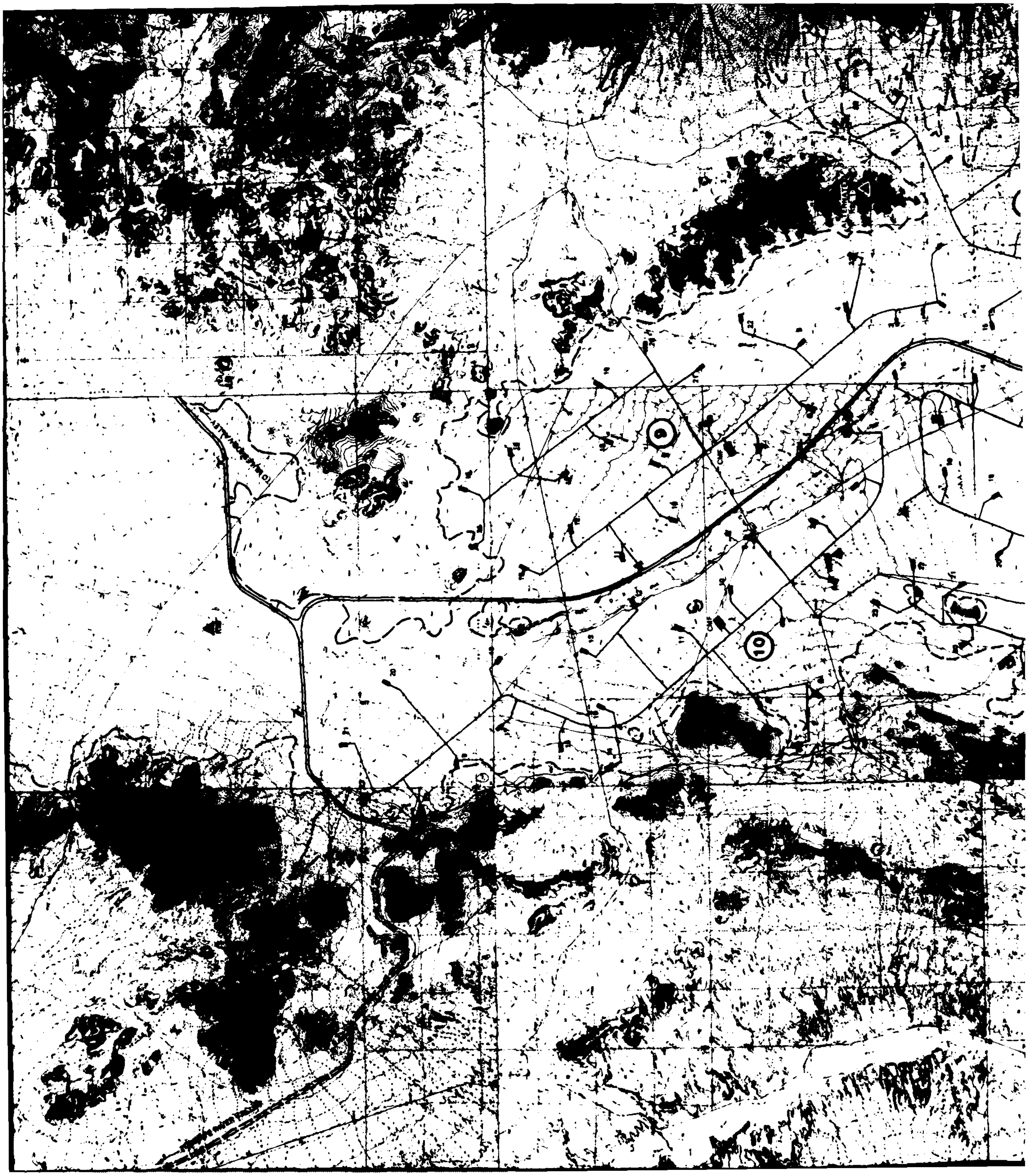
Field surveys started in Pine Valley on 3 November. The field work is expected to be finished in mid-December if there are no delays due to adverse weather. Field work is to start in Wah Wah Valley in early December and will be completed in January or later, depending on weather conditions.

7.5 RESULTS

Since field work is still in progress in Pine and Wah Wah valleys, results are presented only for Dry Lake Valley. Of the 230 shelters located, 15 had to be relocated distances varying from 150 to 1000 feet (46 to 305 m). The reasons for relocation are as follows:

- o six sites because of washes or active drainage areas;
- o two sites because of ground cracks;
- o three sites because of significant archaeological findings;
- o one site because it is near a rock outcrop;
- o one site because of a fault; and
- o two sites because another site was moved.

No CMFs or RSSs had to be moved. A 6-mile (9.7 km) segment of the DTN in the southern part of the valley had to be moved a maximum distance of 400 feet (122 m) to avoid significant archaeological findings.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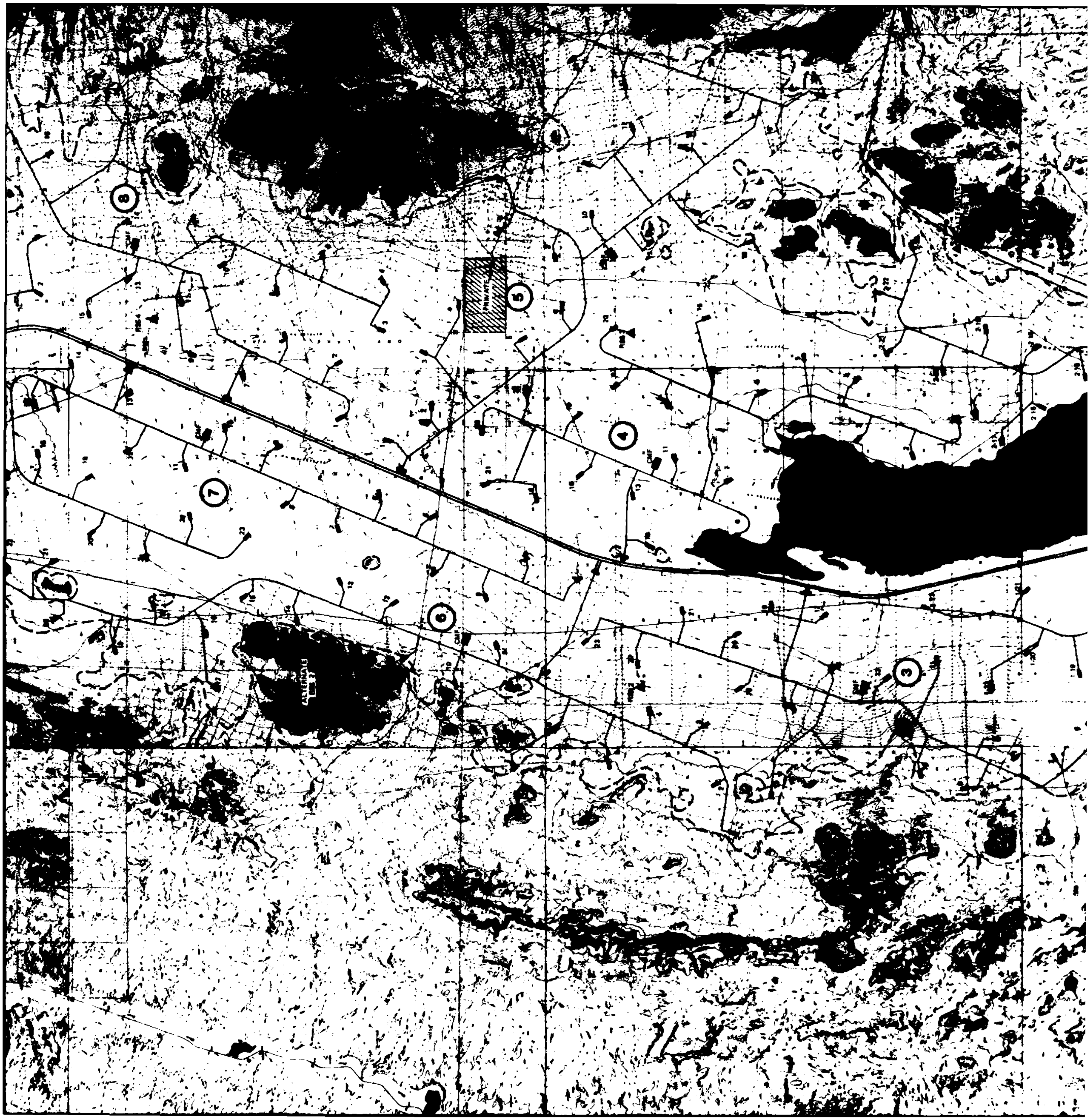
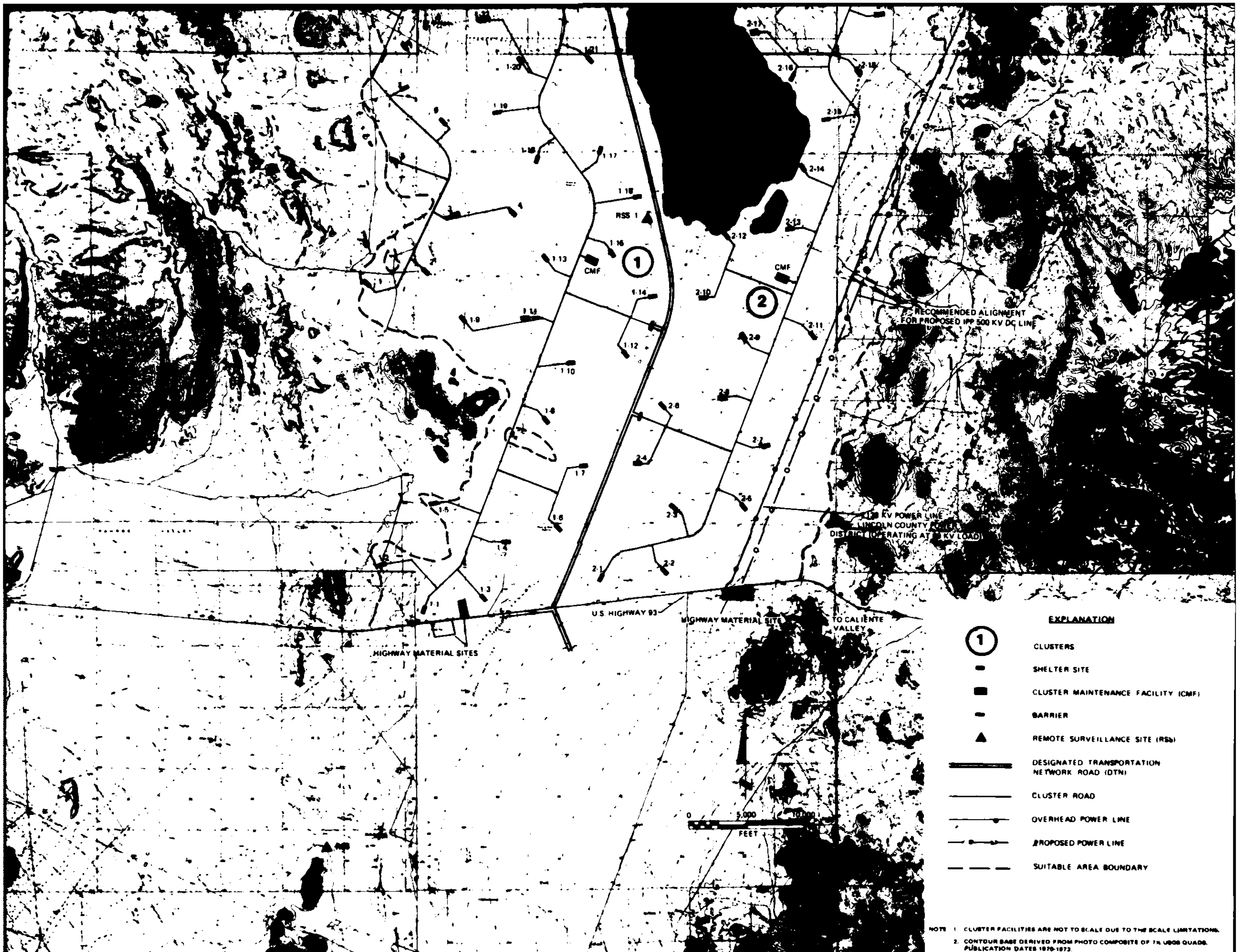




NOTE 1. CLUSTER FACILITIES ARE NOT TO SCALE DUE TO THE SCALE LIMITATIONS.
2. CONTOUR BASE DERIVED FROM PHOTO COMPOSITE OF 7½ USGS QUADS. PUBLICATION DATES 1970-1973.

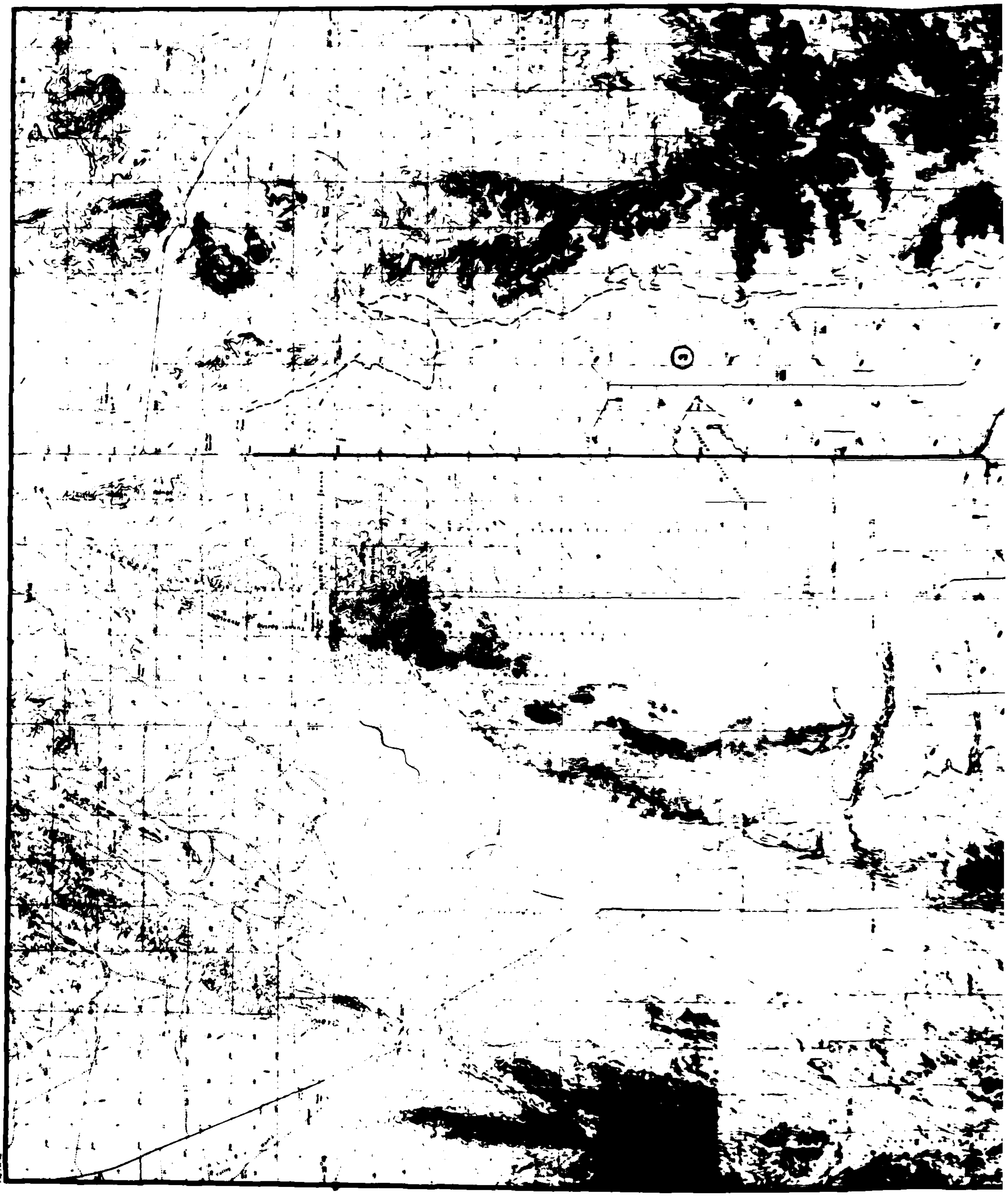
REVISIONS		
REVISION	DATE	REMARKS
A	28 AUG 80	ROAD PATTERN CHANGED TO REDUCE CLUSTER ROAD LENGTHS. CLUSTER INDEX CHANGED TO NUMBERS. ALTERNATE RSS LOCATED BY TRW. RSS LOCATIONS IN DELAMAR AND MULESHOE VALLEYS ADDED TO COMPLETE COVERAGE (THESE SITES WERE NOT INDICATED IN PRIOR LAYOUTS). SHELTER LOCATIONS REFLECT CHANGES MADE DURING 1:9600 MAP TRANSFER

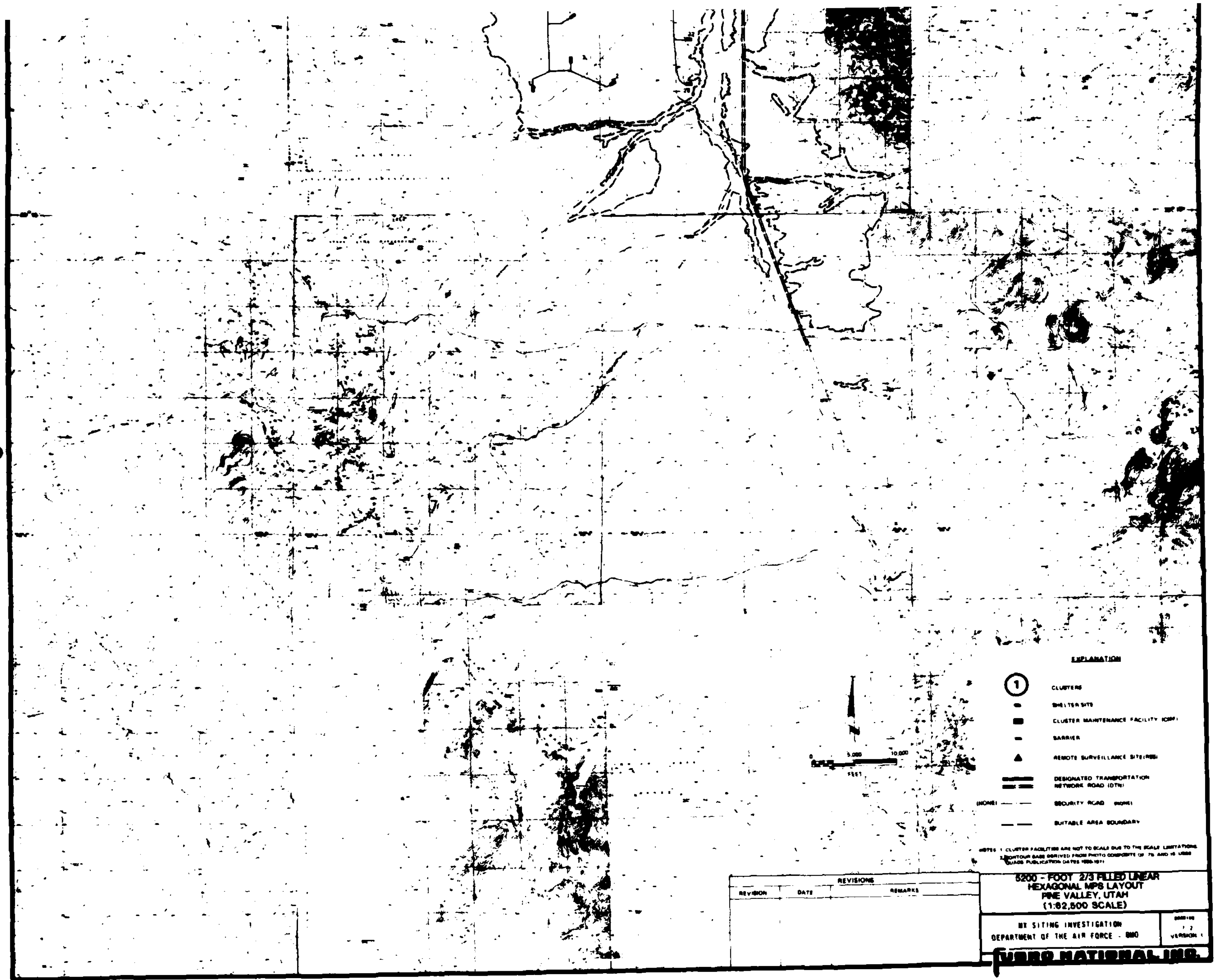
5200 - FOOT 2/3 FILLED LINEAR HEXAGONAL MPS LAYOUT DRY LAKE VALLEY, NEVADA (1:62,500 SCALE)

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

7 1
VERSION 8A

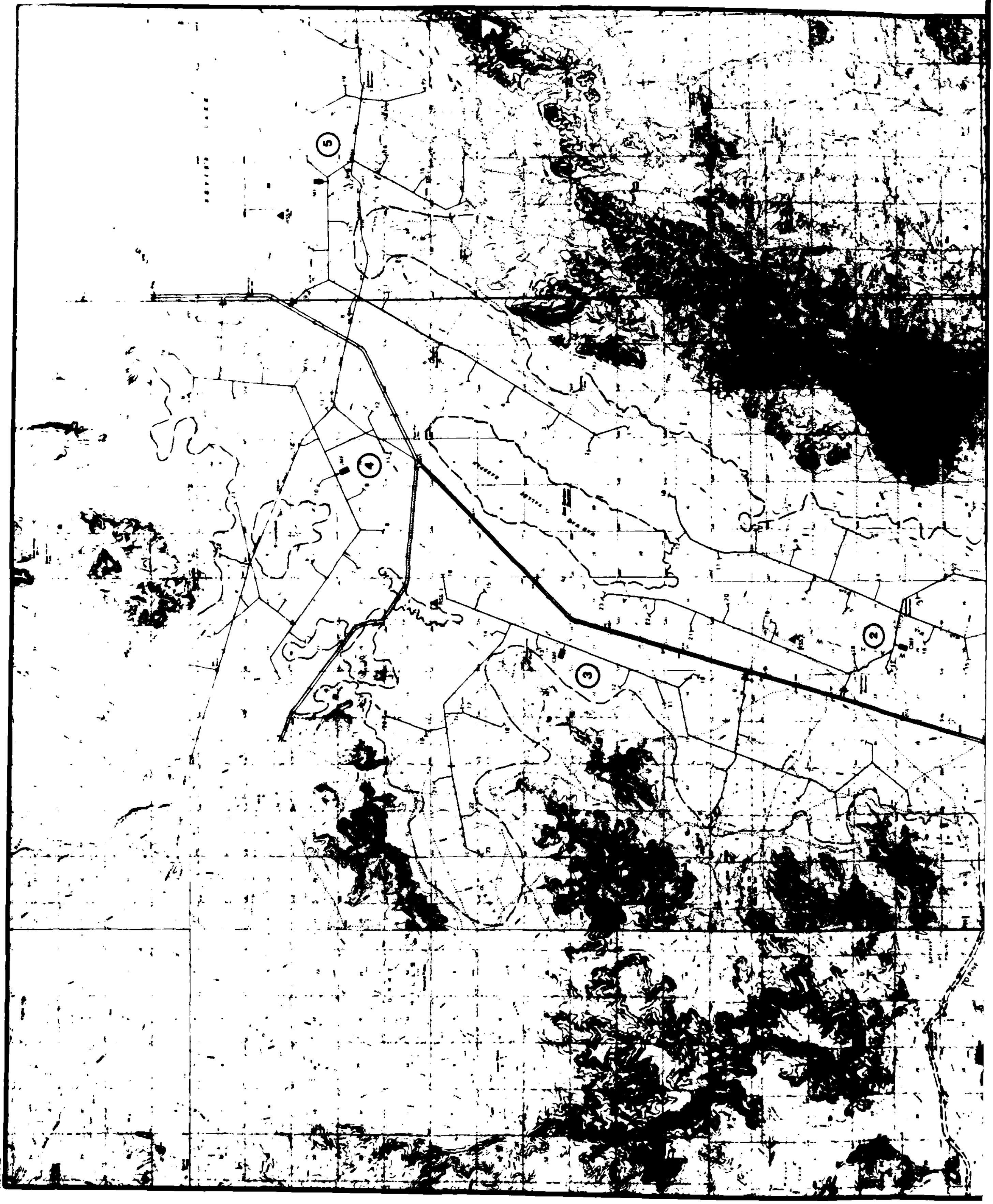
FUGRO NATIONAL, INC.





PRELIMINARY
SUBJECT TO REVIEW

3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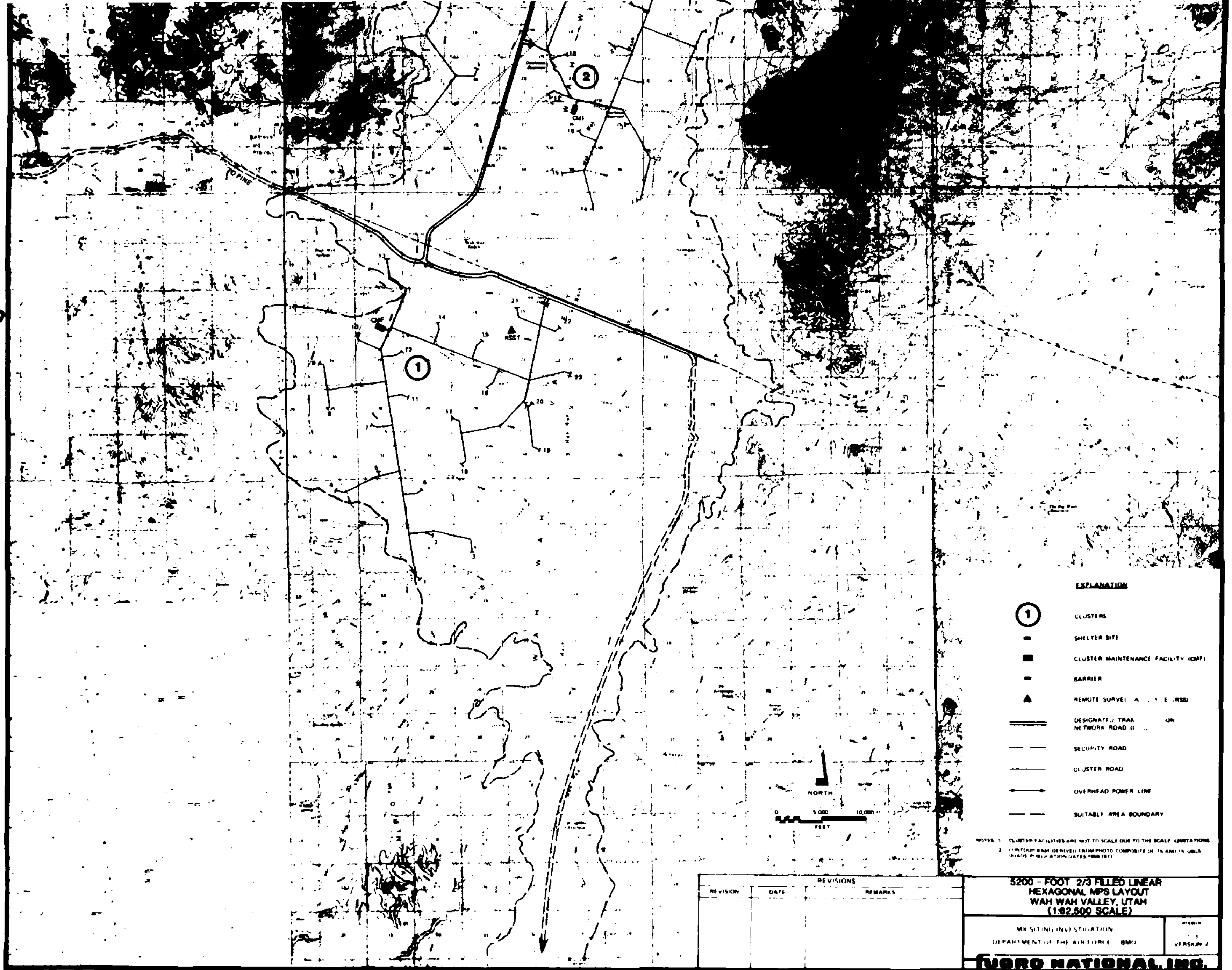


PRELIMINARY
SUBJECT TO REVIEW

8.0 OPERATIONAL BASE STUDIES

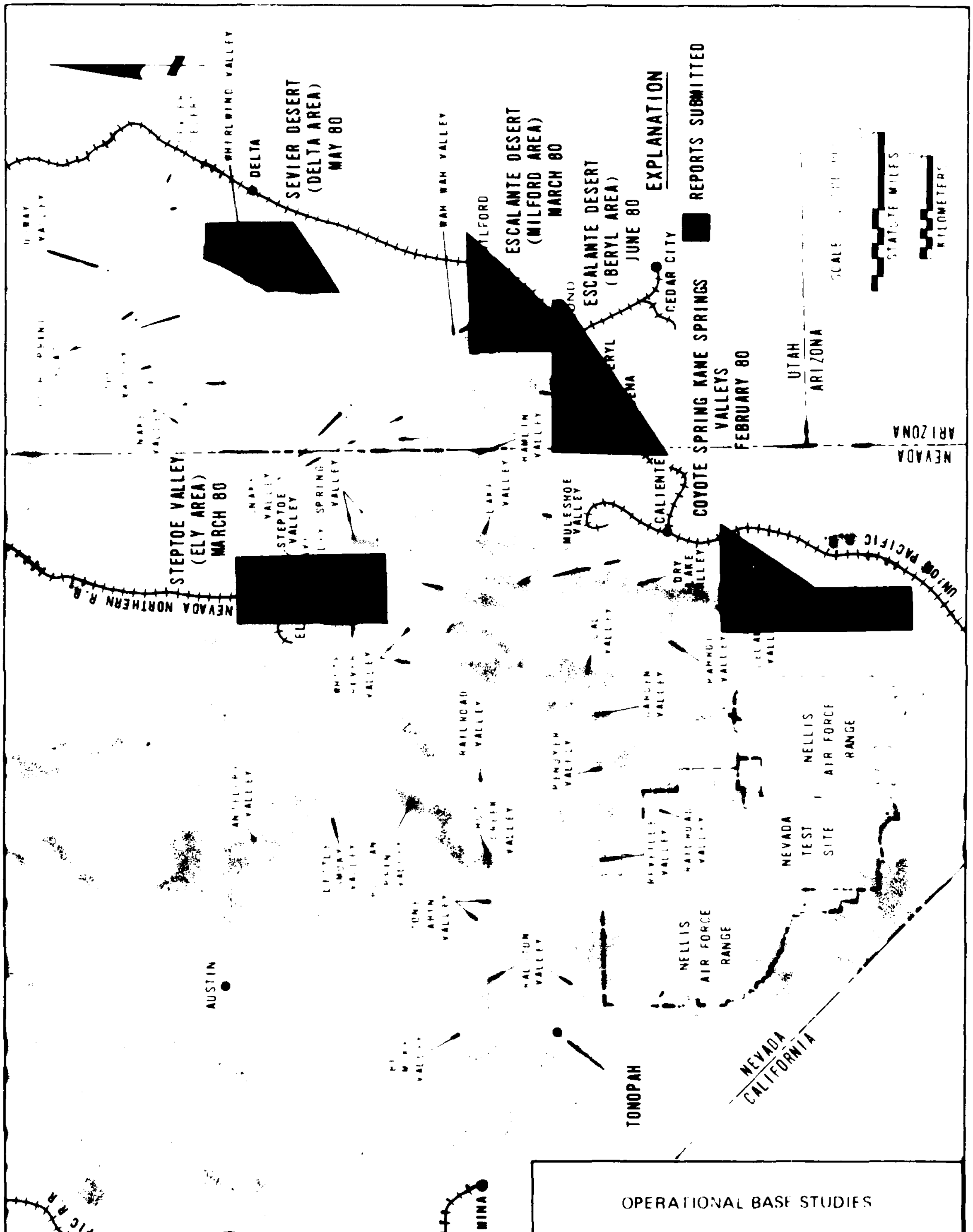
8.1 BACKGROUND

In November 1979, Fugro National was tasked to conduct studies supporting the selection of an operational base location for the MX system in the Nevada-Utah siting area. The studies were to include information about water supply, land ownership, existing and proposed transportation systems, terrain, and geotechnical conditions. Using this information, Fugro National was to prepare conceptual layouts showing the Operational Base (OB), Designated Assembly Area (DAA), Missile Assembly Buildings (MAB), and Operational Base Test Site (OBTS).

8.2 SCOPE AND OBJECTIVES

The proposed operational sites at Milford, Delta, Ely, Coyote Spring, and Beryl (Figure 8-1) were evaluated to determine their geographic, cultural, geotechnical, and geohydrologic characteristics. Geographic and cultural data were compiled from BLM master title plats and available topographic maps. The geotechnical and geohydrological conditions were evaluated by a review of geologic and hydrologic literature and maps and by interpretation of aerial photographs (1:25,000 or 1:60,000 scale). In some cases, these data were supplemented with data from the ongoing Verification studies.

In general, the studies were limited to evaluating the relative suitability of the areas as potential OB sites using subjective geotechnical criteria. Proposed options for operational base layouts were based on best estimates of the actual conditions



OPERATIONAL BASE STUDIES

MX SITING INVESTIGATION

DEPARTMENT OF THE AIR FORCE BMO

FIGURE

FUGRO NATIONAL, INC.

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on-site and, at least initially, no ground reconnaissance was made of the sites. Separate reports on each of the five potential sites were submitted to the BMO/AFRCE between 27 February and 13 June 1980.

8.3 SITING STUDIES

8.3.1 Chronology

At the outset of the siting studies, it was recognized that extensive investigation would be required before a final site could be selected. It was decided, therefore, that Fugro National would begin by quickly providing as much information as possible about a number of sites. In response, Fugro National submitted a preliminary report on 21 December 1979 titled "Initial Operational Base Report." Eleven possible sites were identified in that report and various conceptual layout options were presented.

In January 1980, Fugro National was informed by the BMO that Strategic Air Command's (SAC's) preference for an operational base was the Coyote Spring/Kane Springs area in Nevada. Fugro National, therefore, concentrated its continuing studies in this area. An interim report on Coyote Spring and Kane Springs valleys was submitted on 27 February 1980 (FN-TR-35).

Subsequently, Fugro National was asked to study possible operational base locations in the Milford area of Escalante Desert, Utah, the Ely area of Steptoe Valley, Nevada, and the Delta area of Sevier Desert, Utah. Reports on the Milford, Ely, and Delta

area sites were submitted to the BMO/AFRCE on 10 March, 31 March, and 15 May 1980, respectively.

In May 1980, the Strategic Air Command had completed an evaluation of potential OB sites with a resulting preference for the Beryl area in Escalante Desert, Utah. Fugro National was requested to conduct a study of the Beryl area similar to those done for the other potential sites. The report on the Beryl area was submitted on 13 June 1980. This report, like its predecessors, included several OB layout options, as well as general geotechnical, geohydrologic, cultural, and geographic information for the study area.

On 16 July 1980, a working group on operational base siting was formed by the AFRCE. The purpose of the group was to integrate the base siting efforts of several Air Force agencies and subcontractors toward the single objective of identifying land for withdrawal. In addition to Fugro National, the group included SAC, BMO, AFRCE, Strategic Air Command Systems Operation (SACSO), TRW, Parsons, Martin Marietta, and the Corps of Engineers. In mid-August, the working group made a reconnaissance of each of the five sites, at which time, the siting preferences of the members were aired, and numerous layout options were developed. Refined layouts, based on the siting preferences of this group, were completed on 20 August 1980, at which time boundaries for a real estate study (preparatory to land withdrawal/acquisition) were provided to the Corps of Engineers.

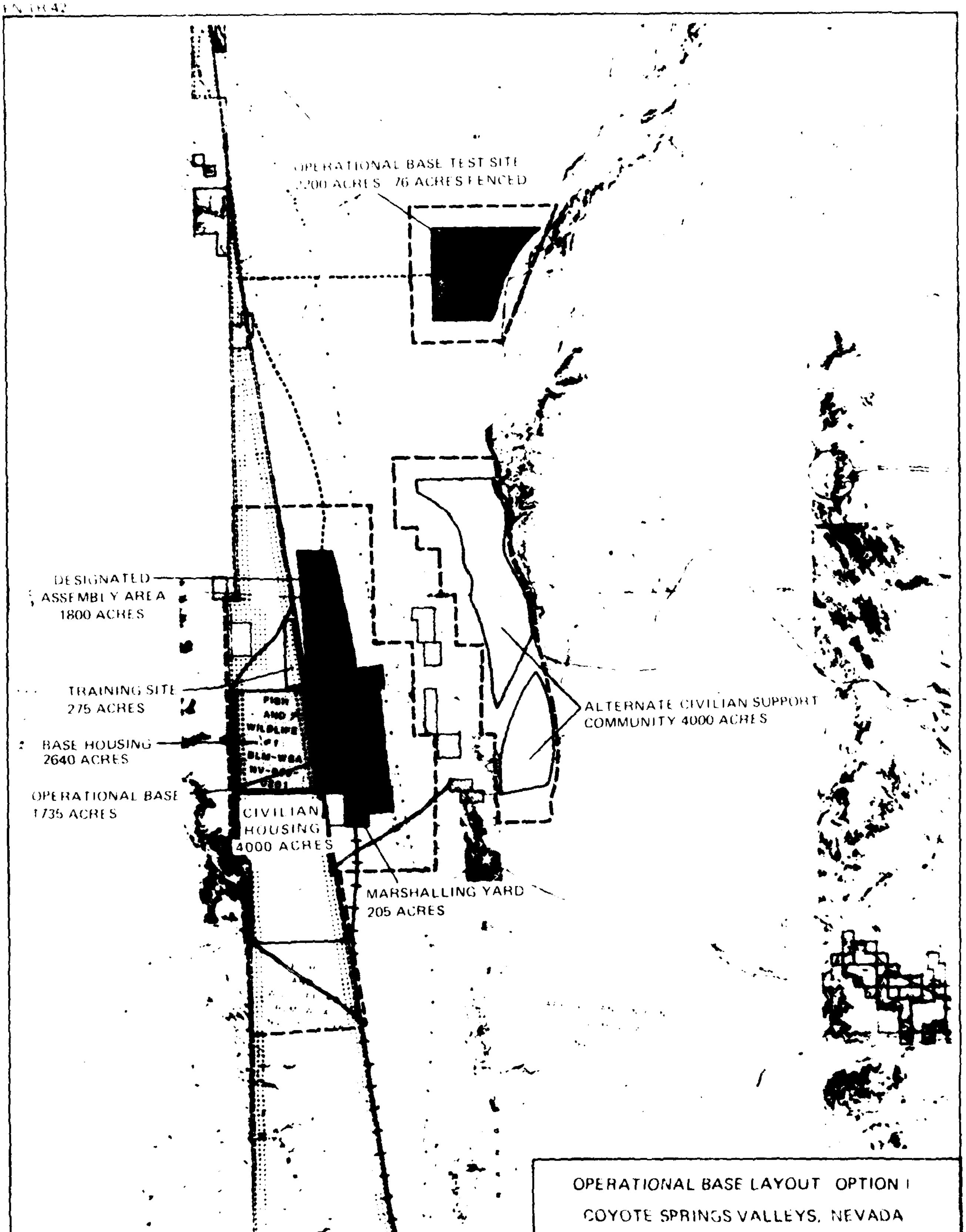
8.3.2 Layout Options

The operational base will include; 1) the main base, 2) a designated assembly area, 3) an operational base test and training site, 4) the support community (military), and 5) a marshalling yard. Each of the centers has a specified size (Table 8-1) and, in some cases, a specified distance from other centers or structures. Additionally, for most of the centers, there are preferred siting conditions, i.e., conditions which are desirable but which are not specified criteria.

Layout options for the five sites (based on the working group preferences) are shown in Figures 8-2 through 8-9. These layouts are responsive to the required area and separation distance specifications. At the same time, they represent an attempt to optimize the base siting to the geotechnical and cultural conditions in the siting areas. Geotechnical and cultural conditions for each layout option are summarized in Table 8-2.

8.4 ADDITIONAL STUDIES

Additional office and field studies in each of the OB site areas were planned during August and September 1980. These studies are designed to provide preliminary technical data on characteristics of each OB site and will be part of the FY 81 program.



OPERATIONAL BASE LAYOUT OPTION I
COYOTE SPRINGS VALLEYS, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

FIGURE 8 2

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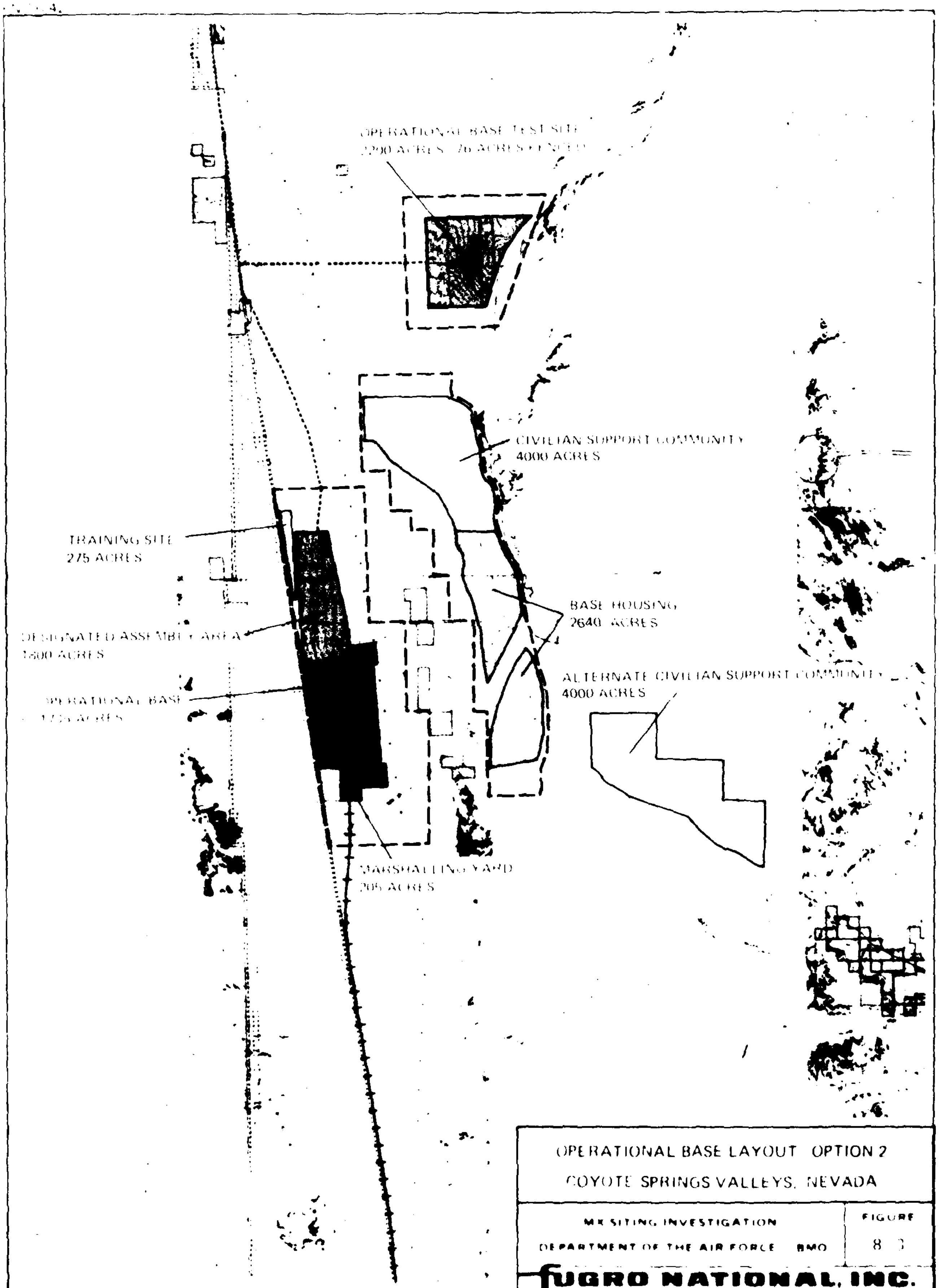
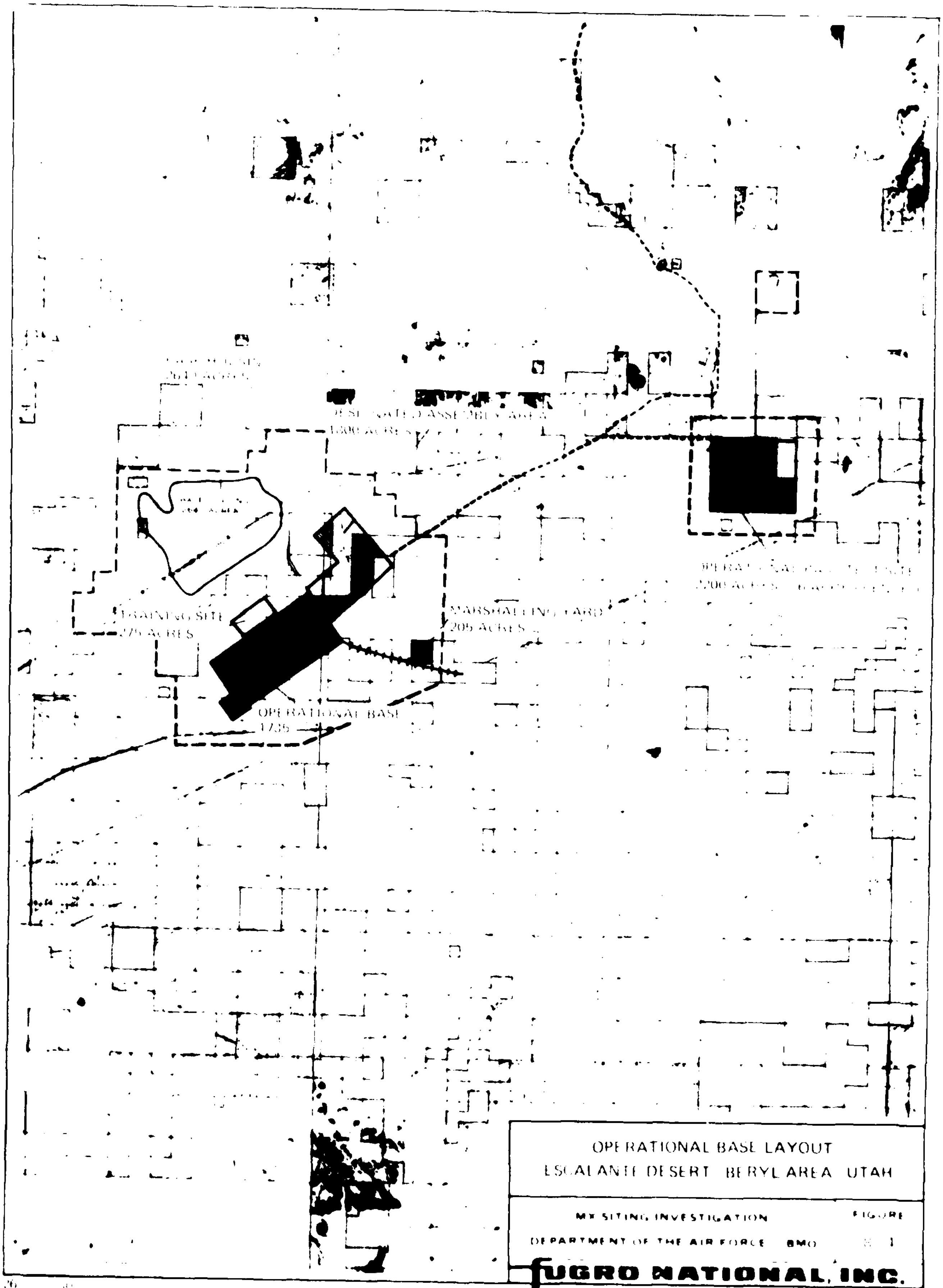


OPERATIONAL BASE LAYOUT OPTION 2
COYOTE SPRINGS VALLEYS, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

FIGURE 8-3

FUGRO NATIONAL, INC.



OPERATIONAL BASE LAYOUT
ESCALANTE DESERT BERYL AREA UTAH

MX SITING INVESTIGATION

DEPARTMENT OF THE AIR FORCE BMO

FIGURE

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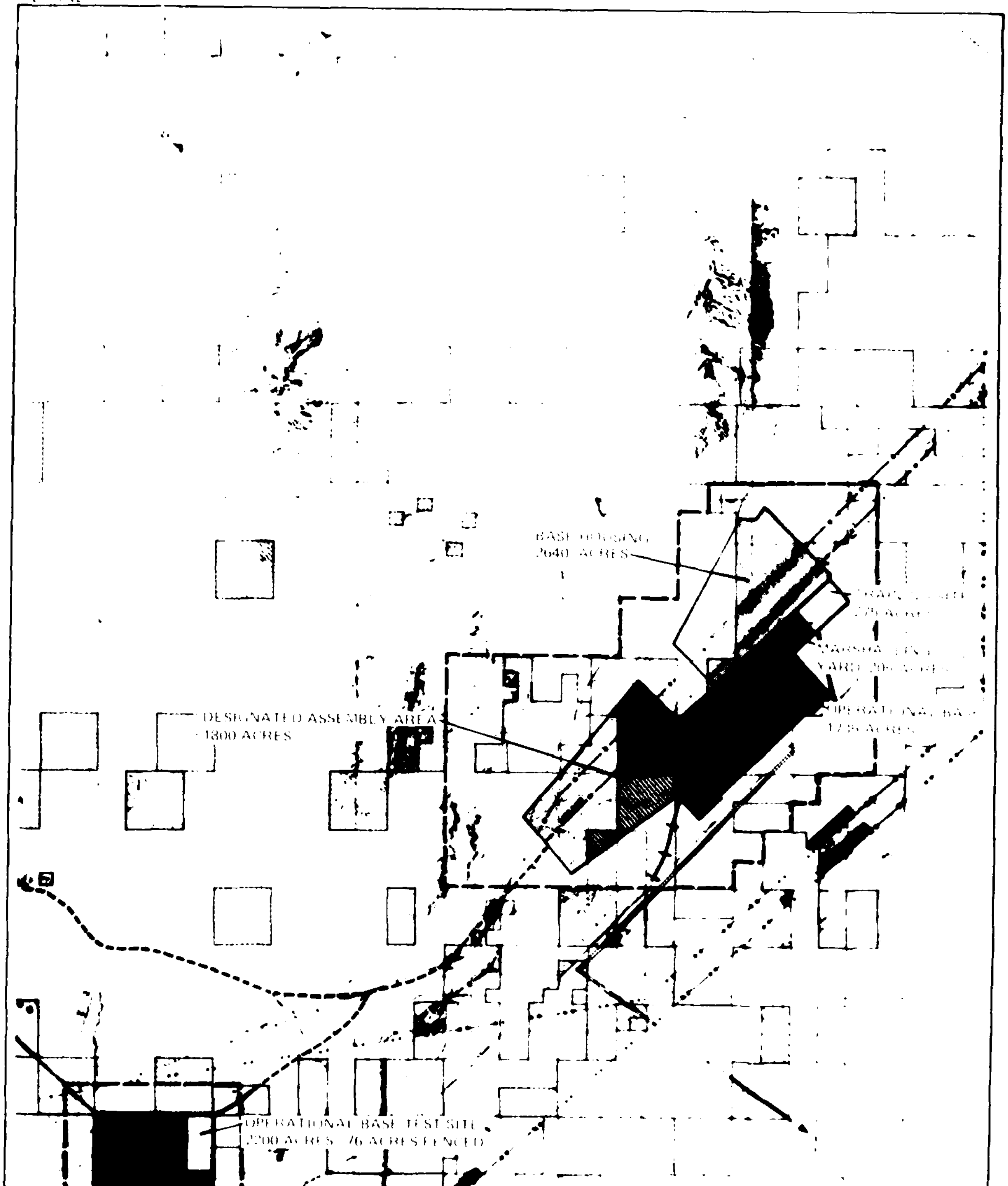

OPERATIONAL BASE LAYOUT OPTION 1

ESCALANTE DESERT MILFORD AREA, UTAH

MX SITING INVESTIGATION

DEPARTMENT OF THE AIR FORCE - BMO

FIGURE 8

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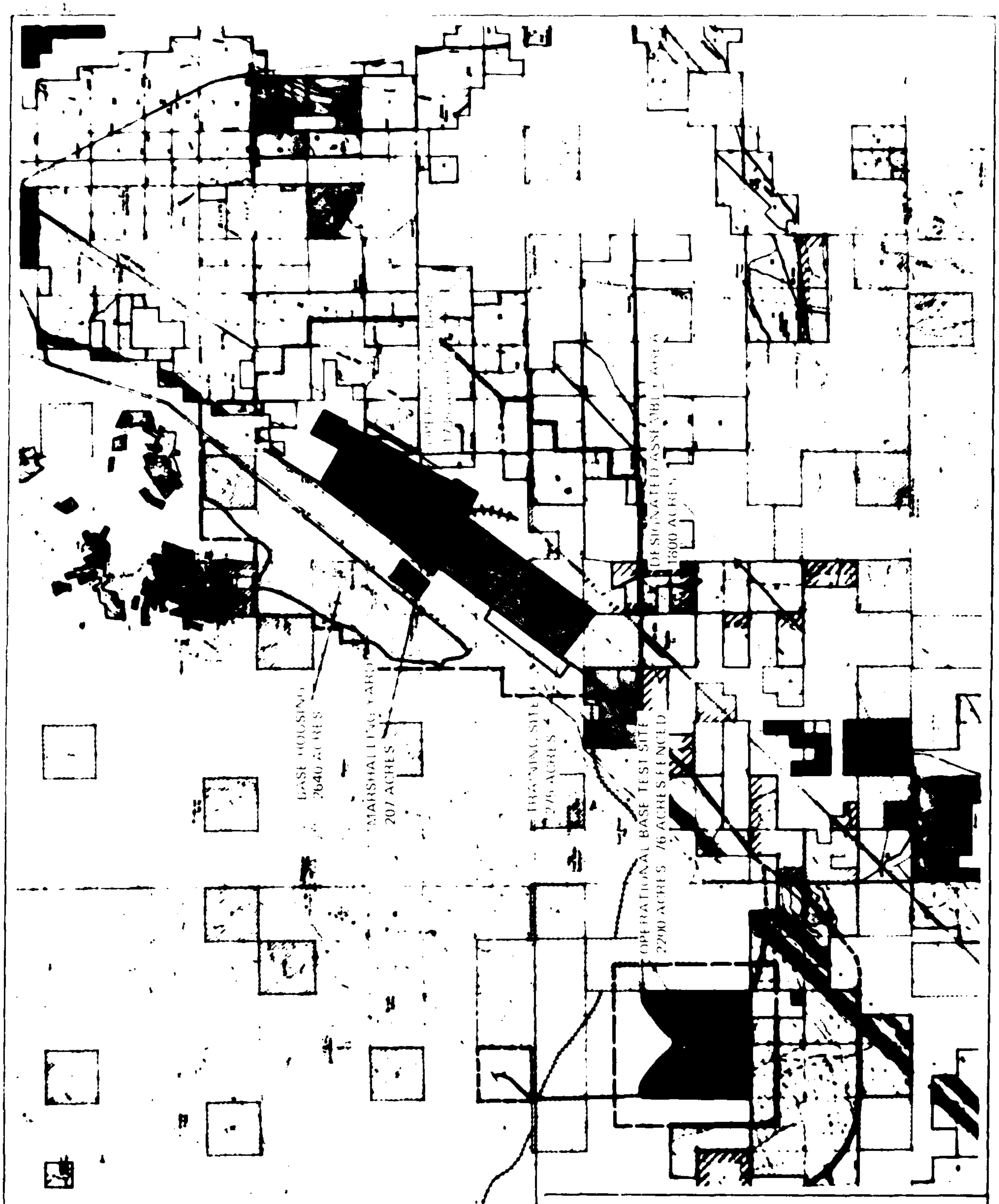

OPERATIONAL BASE LAYOUT OPTION 2
ESCALANTE DESERT, MILFORD AREA, UTAH

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

FIGURE 8 6

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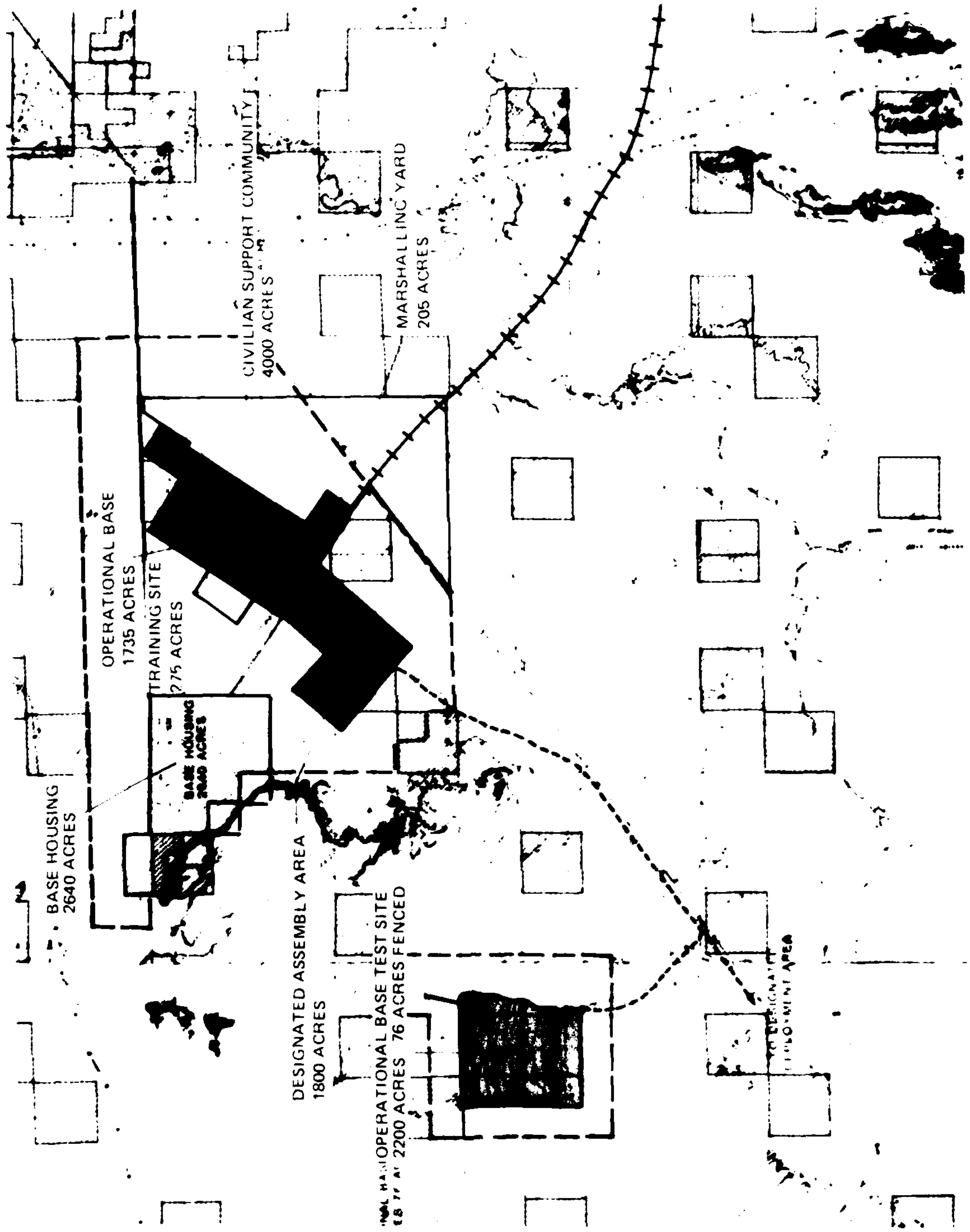

OPERATIONAL BASE LAYOUT
SEVIER DESERT, DELTA AREA, UTAH

MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE - BMO	FIGURE 8-7

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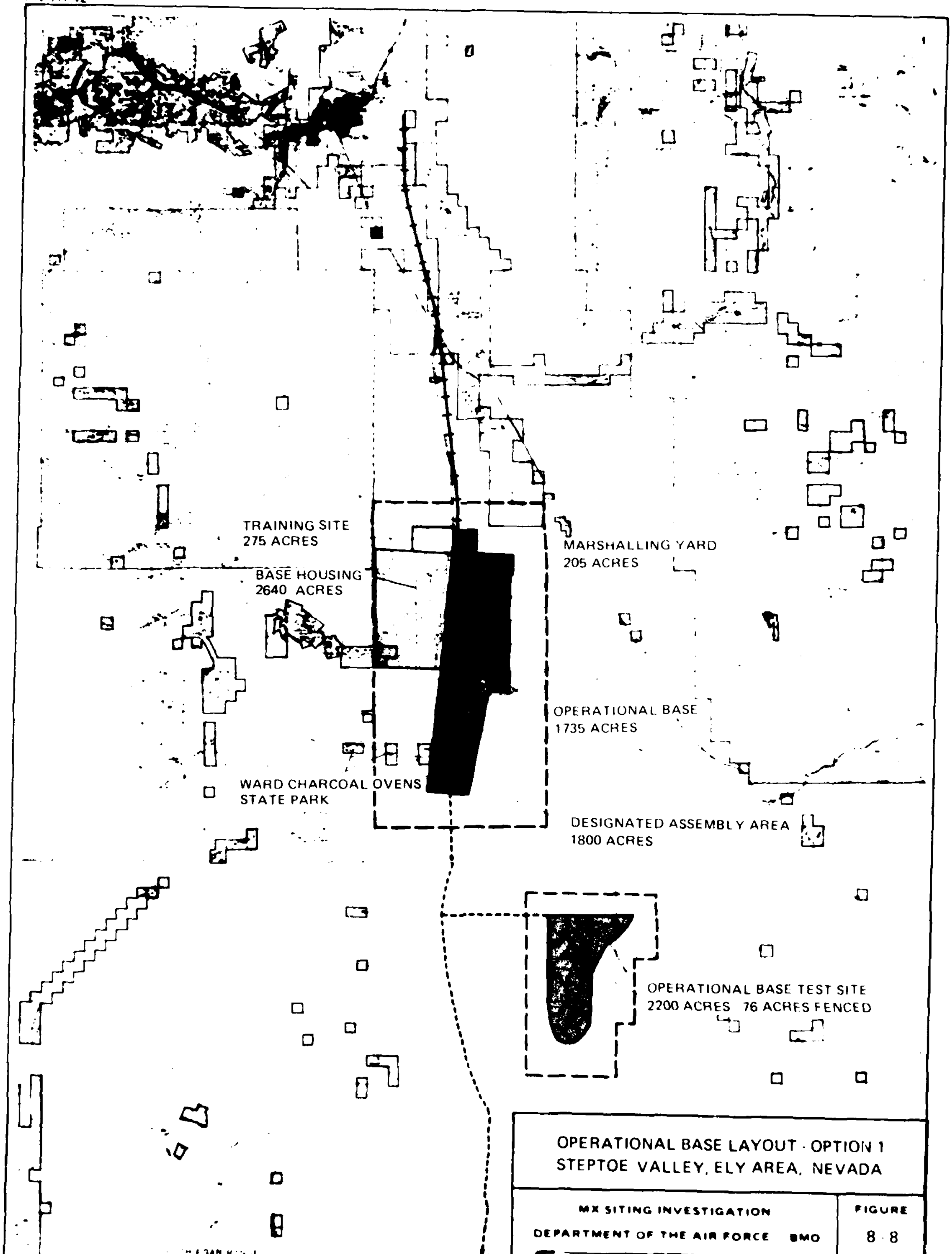

OPERATIONAL BASE LAYOUT - OPTION 1
STEPTOE VALLEY, ELY AREA, NEVADA

MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE BMO	FIGURE 8-8

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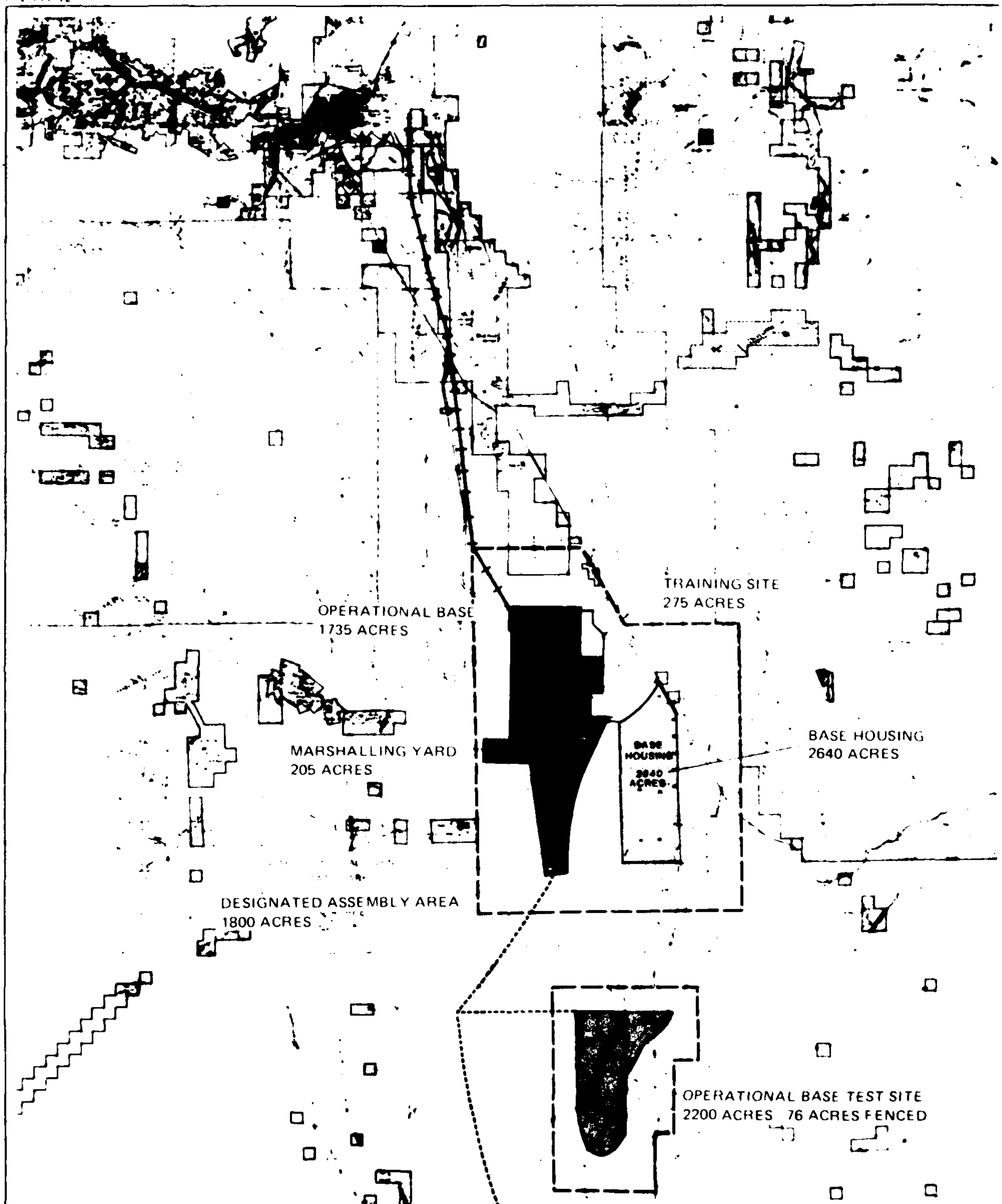

OPERATIONAL BASE LAYOUT OPTION 2
STEPTOE VALLEY, ELY AREA, NEVADA

MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE BMO	FIGURE 8-9

FUGRO NATIONAL, INC.

COMPONENTS	ACRES	MILES^2
• OPERATIONAL BASE (OB)	1735	2.7
– RUNWAY		
– OB SUPPORT FACILITIES		
– MX SUPPORT FACILITIES		
• DESIGNATED ASSEMBLY AREA (DAA)	1800	2.8
– PRODUCTION MISSILE ASSEMBLY AREA		
– MAINTENANCE MISSILE ASSEMBLY AREA		
– DAA SUPPORT FACILITIES		
– WEAPONS STORAGE AREA		
• OPERATIONAL BASE TEST AND TRAINING SITE (OBTS)	2200 (76 FENCED)	3.4 (0.12)
– CLUSTER MAINTENANCE FACILITY (CMF)		
– TEST SUPPORT BUILDING (TSB)		
– HORIZONTAL SHELTER SITES (HSS) WITH ONE NUCLEAR HARDNESS AND SURVIVABILITY (NH+S) HSS		
– REMOTE SURVEILLANCE SITE (RSS)		
• MARSHALLING YARD	205	0.32
• MILITARY SUPPORT COMMUNITY	2640	4.1
– DEPENDENT HOUSING		
COMMUNITY CENTER		
– MEDICAL SERVICES		
SUBTOTAL	8580	13.44
• CIVILIAN SUPPORT COMMUNITY	4000	6.25
TOTAL	12,580	19.69

OPERATIONAL BASE
COMPONENTS AND AREA ESTIMATES

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

TABLE 9-1

FUGRO NATIONAL, INC.

CONDITIONS	BERYL	DELTA	MILFORD	COYOTE	ELY
GROUND-WATER - AVAILABILITY	BY PURCHASE	BY PURCHASE (POSSIBLE PERMIT)	BY PURCHASE	UNKNOWN	BY PERMIT
GEOTECHNICAL CONSIDERATIONS WASHES	–	–	(1) TO SE AND SW (2) TO SE	–	–
DUNES	TO S		TO SE	–	–
SHALLOW GROUND WATER	–			UNKNOWN	N END OF BASE
FAULTING		TO E	(1) TO NW AND SE (2) –	(1) – (2) HOUSING AREA	(1) IN ALL AREAS (2) BETWEEN ALL AREAS
DEVIATION FROM UNOBSTRUCTED AIRSPACE – APPROACH/DEPARTURE	–		–	AT S END	AT S END
– REGIONAL	4 MILES NW	4.2 MILES W 5.5 MILES SW	(1) 4 MILES NW (2) 3.5 MILES NW	3.9 MILES E 2.4 MILES W	5 MILES E 2.5 MILES W
LAND STATUS – SENSITIVE AREAS	–	–	–	(1) HOUSING AREA (1,2) ALL AROUND	(1) TO W (2) TO W AND E
– MINING	GEOTHERMAL	–	ACTIVE CLAIMS NW, GEOTHERMAL	–	ACTIVE CLAIMS W OIL GAS LEASES BASE SITE
REROUTING – TRANSMISSION LINES	–		(1) IPP (2) –	IPP	–
– HIGHWAYS	–		–	(1) HWY 7 AND 93 (2) HWY 7	–

OPERATIONAL BASE DATA SUMMARY

MX SITING INVESTIGATION

DEPARTMENT OF THE AIR FORCE – BMO

TABLE 8-2

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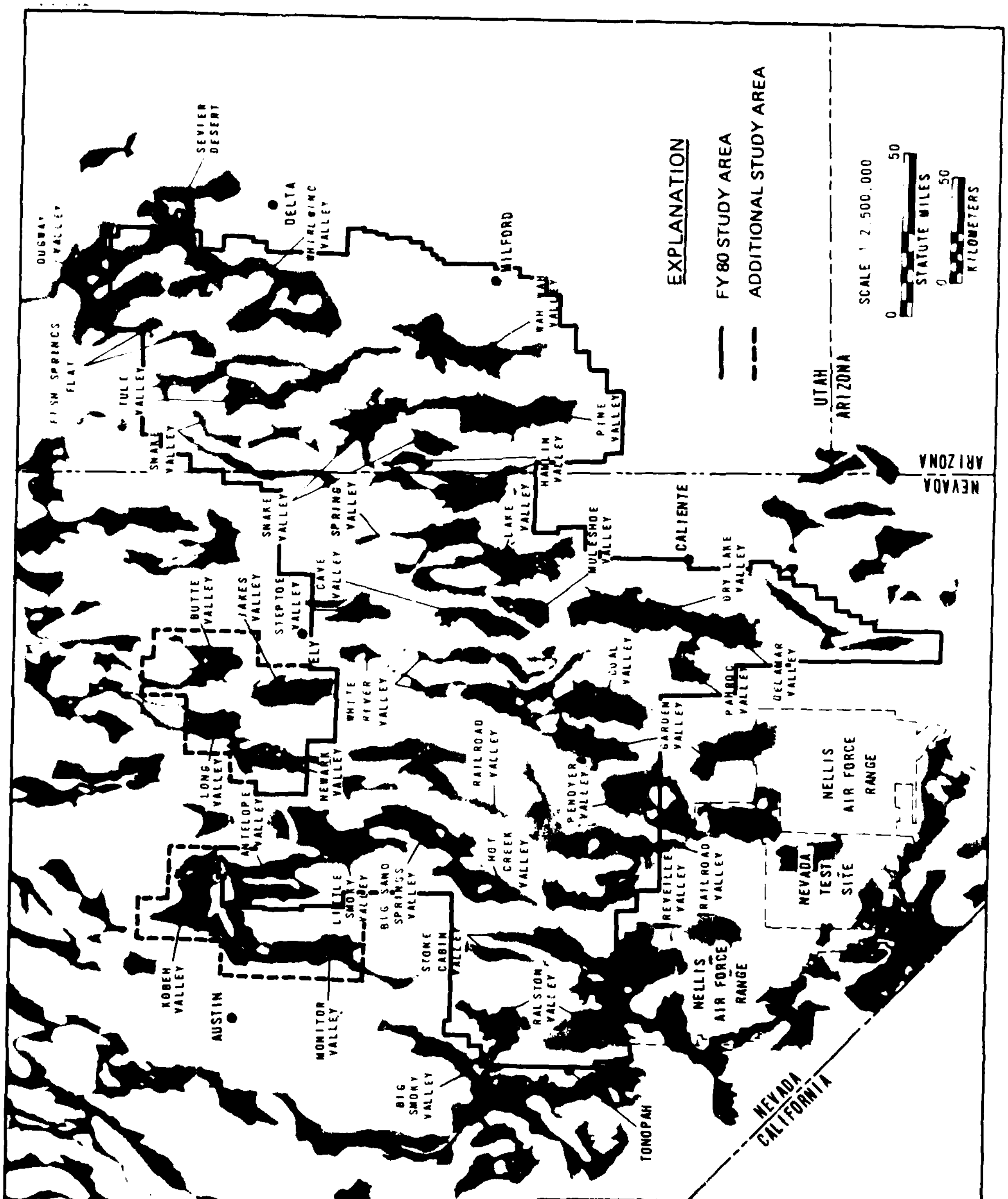
9.0 MINERAL RESOURCES SURVEY

9.1 BACKGROUND, OBJECTIVES, AND APPROACH

In June 1980, Fugro National, Inc. was tasked to carry out a mineral resources survey of the MX siting area in Nevada and Utah (Figure 9-1). The survey was done to develop the necessary information on mineral and energy resource potential to accompany the MX application for land withdrawal. The scope of the survey was guided by the regulations for land withdrawal contained in the Federal Land Policy and Management Act of 1976. The survey was completed in October 1980.

The objective of the Mineral Resources Survey was to inventory and evaluate past and present mineral and energy resource activities in the MX siting area. This was to be done in sufficient detail so that potential future mineral exploitation in the MX deployment areas, and the impacts of the MX system on future mineral activity, may be assessed.

The survey drew heavily on existing published and unpublished data such as geologic and structural data; mine and mining district reports; aeromagnetic, seismic and gravimetric data; and an inventory of all claims and leases. These data were supplemented by an update of the claim and lease inventory, a review of existing high altitude aerial photography and remote sensing data, contact with mining companies and individuals with interests in the siting area, field examination of significant mineral occurrences and major active mining operations, and consultation with experts knowledgeable of present and



MINERAL RESOURCES SURVEY STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

FIGURE 9-1

FUGRO NATIONAL, INC.

26 NOV 80

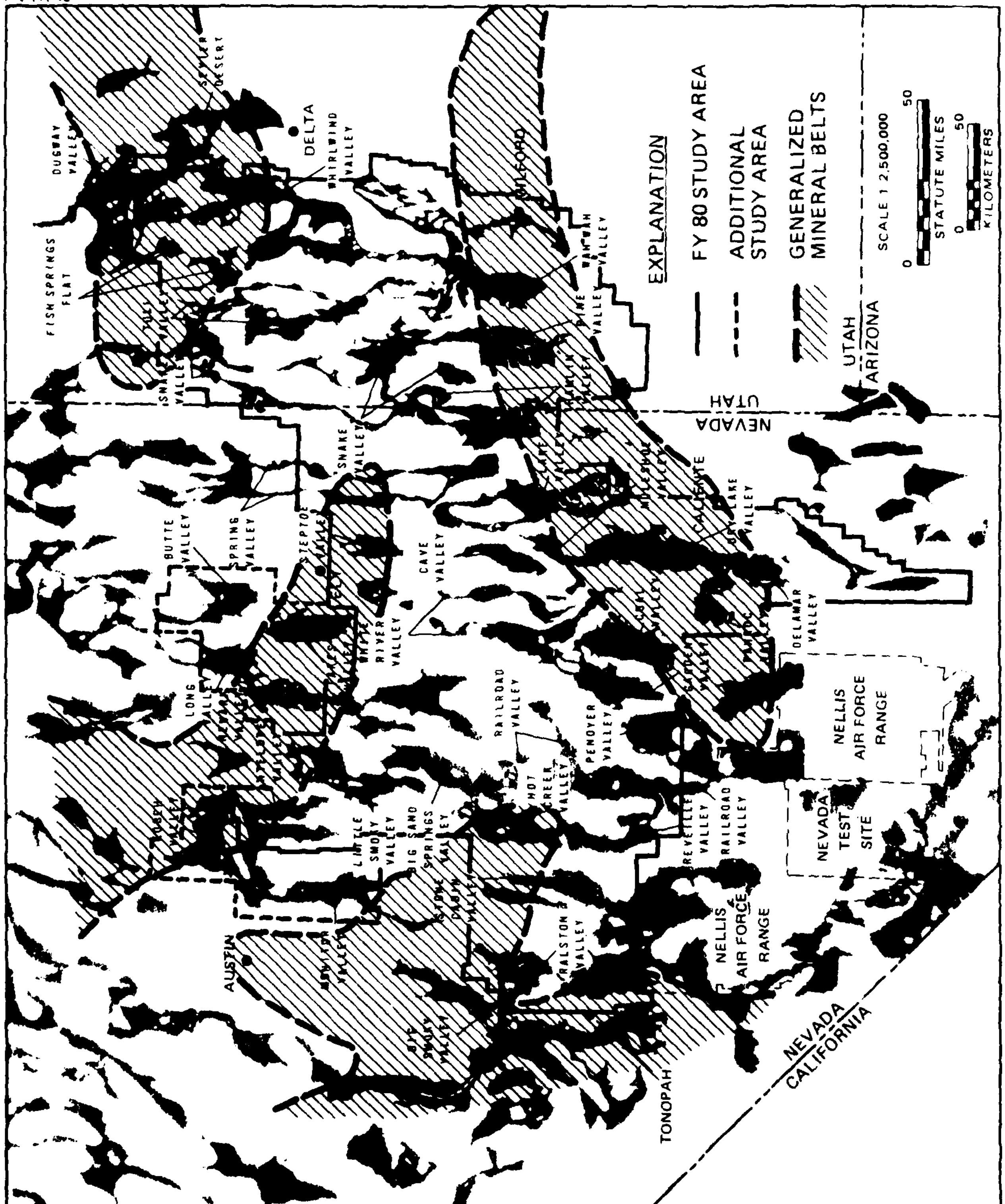
future resource potential in the area. Evaluation of the mineral resources of the entire MX siting area provided a framework within which the resource potential in the MX deployment areas could be assessed. In addition, the potential market demands of the mineral commodities in the siting area were considered.

9.2 NEVADA-UTAH MX SITING AREA

The Basin and Range geologic province, which includes the MX siting area, is one of the most highly mineralized areas in the United States. The local sedimentary and igneous rocks, as well as the overall tectonic framework of the Basin and Range Province, have both contributed to the formation and localization of economic deposits of metals, nonmetallic minerals, and oil and gas. This localization has occurred along major metallogenic provinces or "mineral belts" in Nevada and Utah (Figure 9-2).

The mountain-valley physiography which typifies the Basin and Range Province has largely limited historical mineral exploitation to the exposed mountain areas, while the alluvium-filled valleys have been little explored. More recent exploration has drifted toward the valley areas where favorable geologic conditions exist beneath the valley-fill materials.

The principal metals produced in the siting area are: silver, gold, lead, zinc, copper, tungsten, molybdenum, uranium, and beryllium. The principal nonmetallic minerals are: alunite,



GENERALIZED MINERAL BELTS,
NEVADA - UTAH

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE – BMO

FIGURE 9-[illegible]

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barite, and fluorspar. Some oil and gas production also occurs in the siting area.

The Mineral Resources Survey considered four classifications of mineral potential: high, good, speculative, and low. Based on known mineral occurrences (including oil and gas) and favorable geologic environments within the siting area, evaluations of mineral potential for new economic discoveries to the year 2000 and beyond were made.

9.3 MX DEPLOYMENT AREAS

It is expected that there will be areas in the DDA that could have high or good potential for economic mineral deposits. The geologic ingredients necessary for the generation and storage of oil and gas are present in the siting area, but regional geologic complexity has retarded discoveries.

Implementation of the MX system could cause some hindrance to the mining and petroleum industries, mainly in the form of curtailment in size and scope of exploration, restriction in size of future mining operations, and competition in the marketplace for labor and materials. Construction of the system will, of necessity, spur the development and mining of aggregate and stone materials.

10.0 FAULT AND EARTHQUAKE HAZARDS PROGRAM

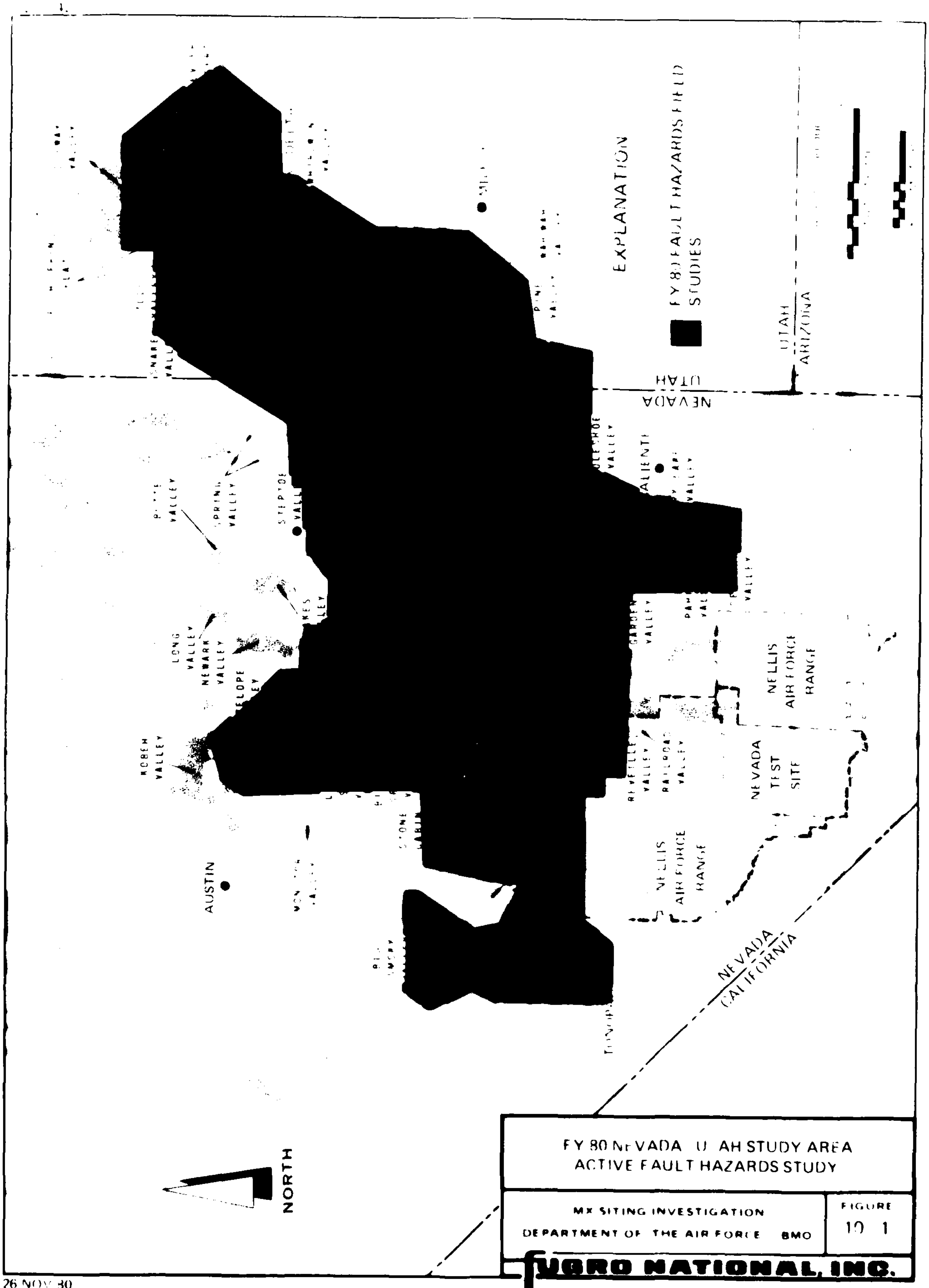
10.1 BACKGROUND, SCOPE, AND OBJECTIVES

The Nevada-Utah siting region, although not among the most seismically active areas in the western United States, is nonetheless situated in a geologic province characterized by historically large earthquakes and active faults. The most significant potential earthquake hazards for the MX system are fault ruptures beneath hardened facilities and strong ground shaking which could interrupt operations. Additionally, system operations may be affected by ground ruptures beneath the transportation and communications networks.

Fugro National's investigation of active-fault and earthquake hazards to date has consisted of 1) a literature study aimed at characterizing the seismicity of the Nevada-Utah siting region, and 2) a series of office and field studies to delineate active or potentially active faults in the FY 79 and FY 80 Verification valleys. The results of the regional seismic assessment, as well as the office portions of the valley-by-valley study of faulting in the FY 79 Verification sites, were submitted in a report titled "Interim Report on Active Faults and Earthquake Hazards" (FN-TR-36; 26 March 1980). The valleys in which field studies of faulting have been done to date are shown in Figure 10-1.

10.2 REGIONAL ASSESSMENT

To assess the seismic activity in the siting region, Fugro National assembled a listing of epicenters and magnitudes (or



FY 80 NEVADA UTAH STUDY AREA
ACTIVE FAULT HAZARDS STUDY

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

FIGURE 10 1

FUGRO NATIONAL, INC.

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intensities) for all earthquakes which have occurred within 30 miles (48 km) of the Verification valleys. Additionally, data were acquired for all larger, significant earthquakes which have occurred within 200 miles (322 km) of the siting region. This effort utilized our inhouse files, U.S. Geological Survey files, and catalogues compiled by the University of Nevada and the University of Utah. The result is a comprehensive study of known earthquakes which has allowed us to analyze, in detail, the seismicity characteristics of the region.

The regional assessment (Drawing 10-1) shows that the siting region has had a low level of seismicity during historic time compared to other portions of Nevada and Utah. The siting region is flanked by two zones having higher levels of seismic activity. One of these zones (the Dixie Valley-Fairview Peak zone) possesses many of the same geologic characteristics and tectonic style as the siting region. These similarities suggest that the earthquake hazards of the Dixie Valley-Fairview Peak zone may be applicable to the siting region as well.

10.3 VALLEY STUDIES

Fugro National's valley-by-valley study of active fault hazards in the siting region has included:

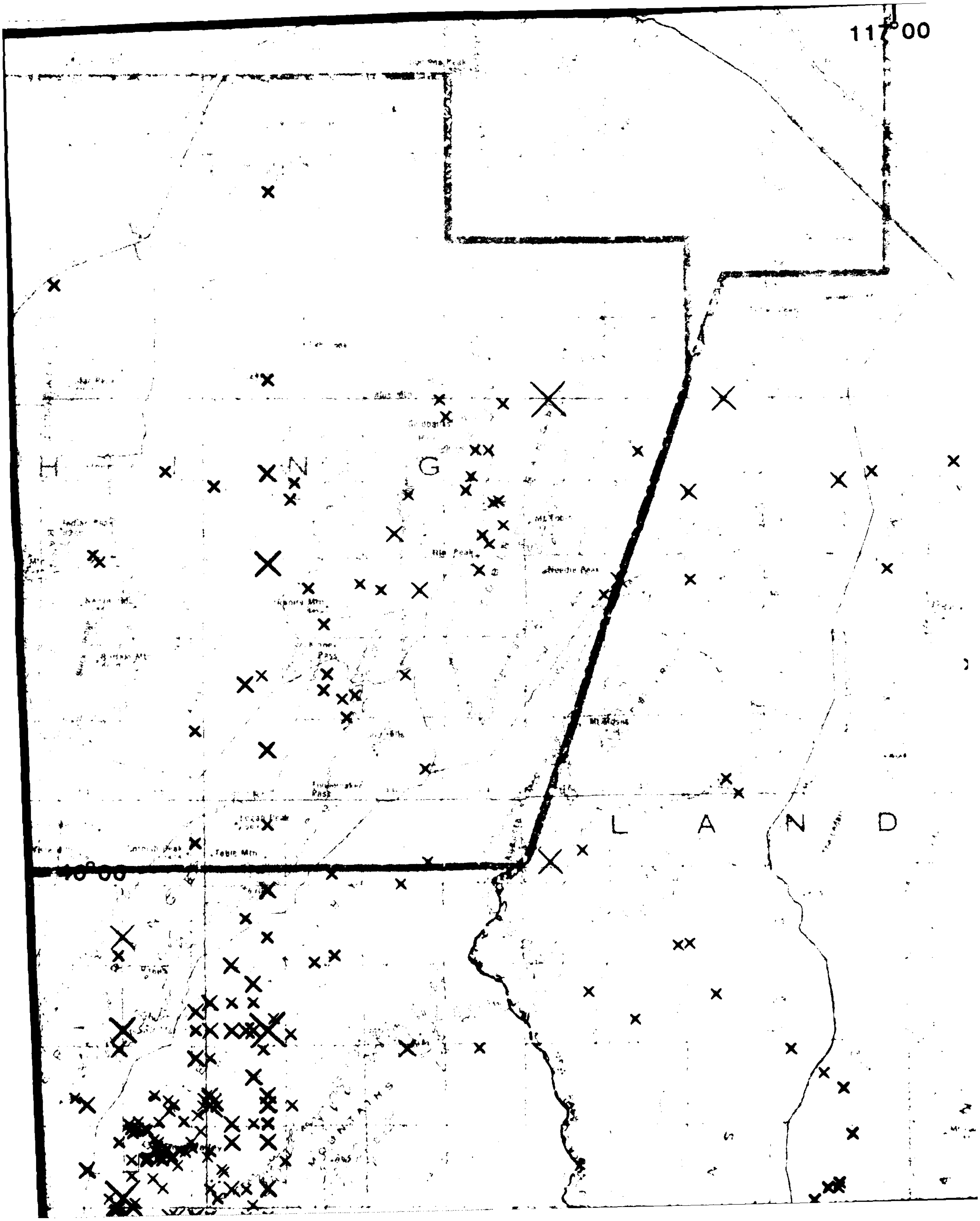
1. Identification of active and potentially active faults from the geologic literature and from the results of our ongoing Verification studies;

2. Identification of active and potentially active faults through a thorough review of the 1:25,000 color stereo air photos; and,

3. Field verification of fault traces and estimates of activity for faults identified in 1 and 2 above.

The results of these studies have been compiled as maps of fault traces at a scale of 1:62,500 and have been utilized in the Verification, Water Resources, Shelter Layout, Mineral Resources, and Operational Base Studies programs.

The valley studies indicate that there are Holocene (<12,000 years old) and Late Quaternary (<700,000 years old) faults in and near the majority of the FY 79 and FY 80 Verification valleys (Drawing 10-2). Most of these young faults have a vertical component of displacement and often form conspicuous steps (up to 20 feet [6 m] high) in the alluvium or colluvium at or near the base of the mountains. Typical of Great Basin faulting, most of the faults observed during this study are down-to-basin normal faults. Although many short segments trend northeasterly and lie within the alluvium of the basins well away from the mountains, the major trends are more northerly and form mountain-block bounding faults.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A
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Needle Peak
Table Mtn
40°00
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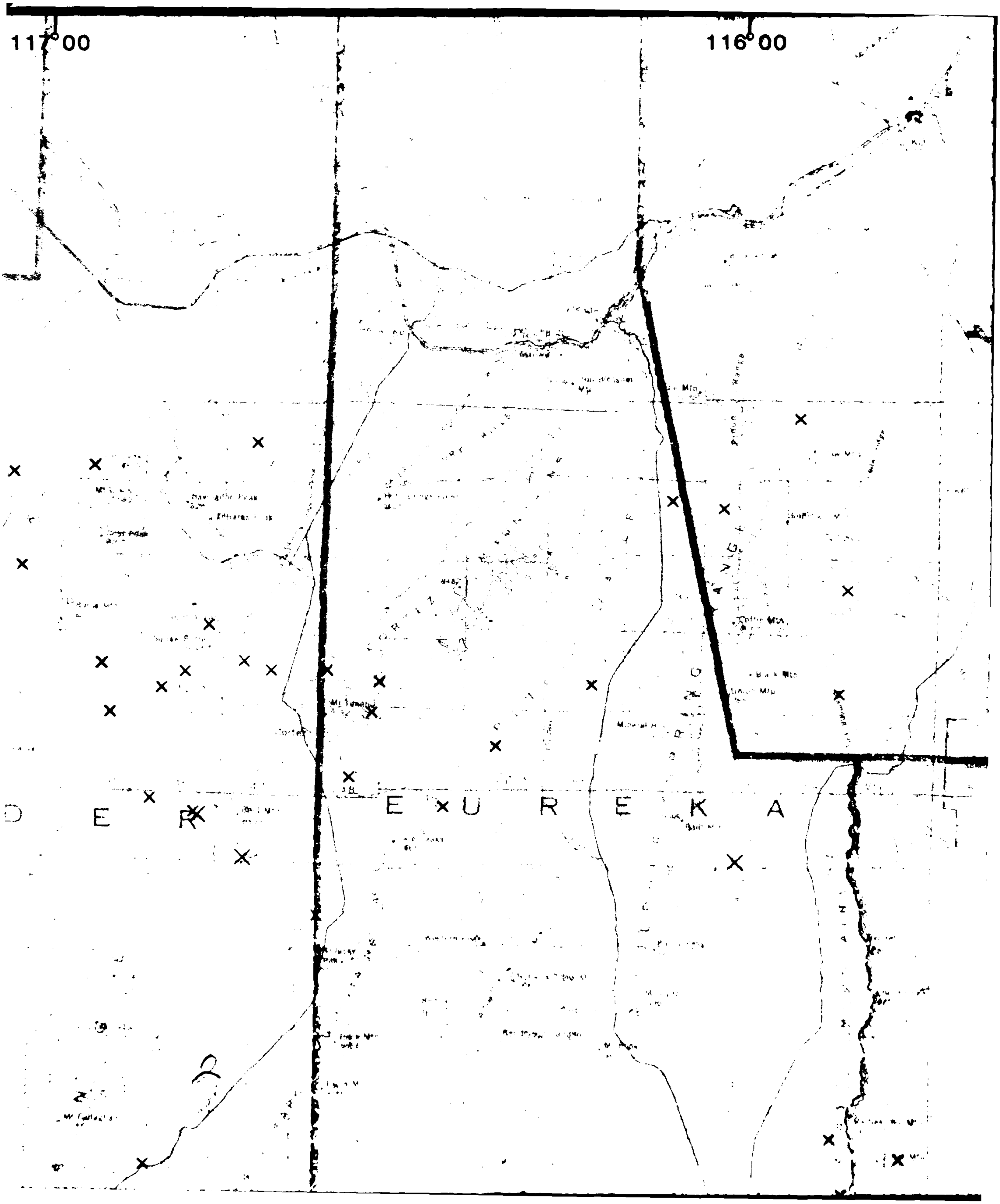
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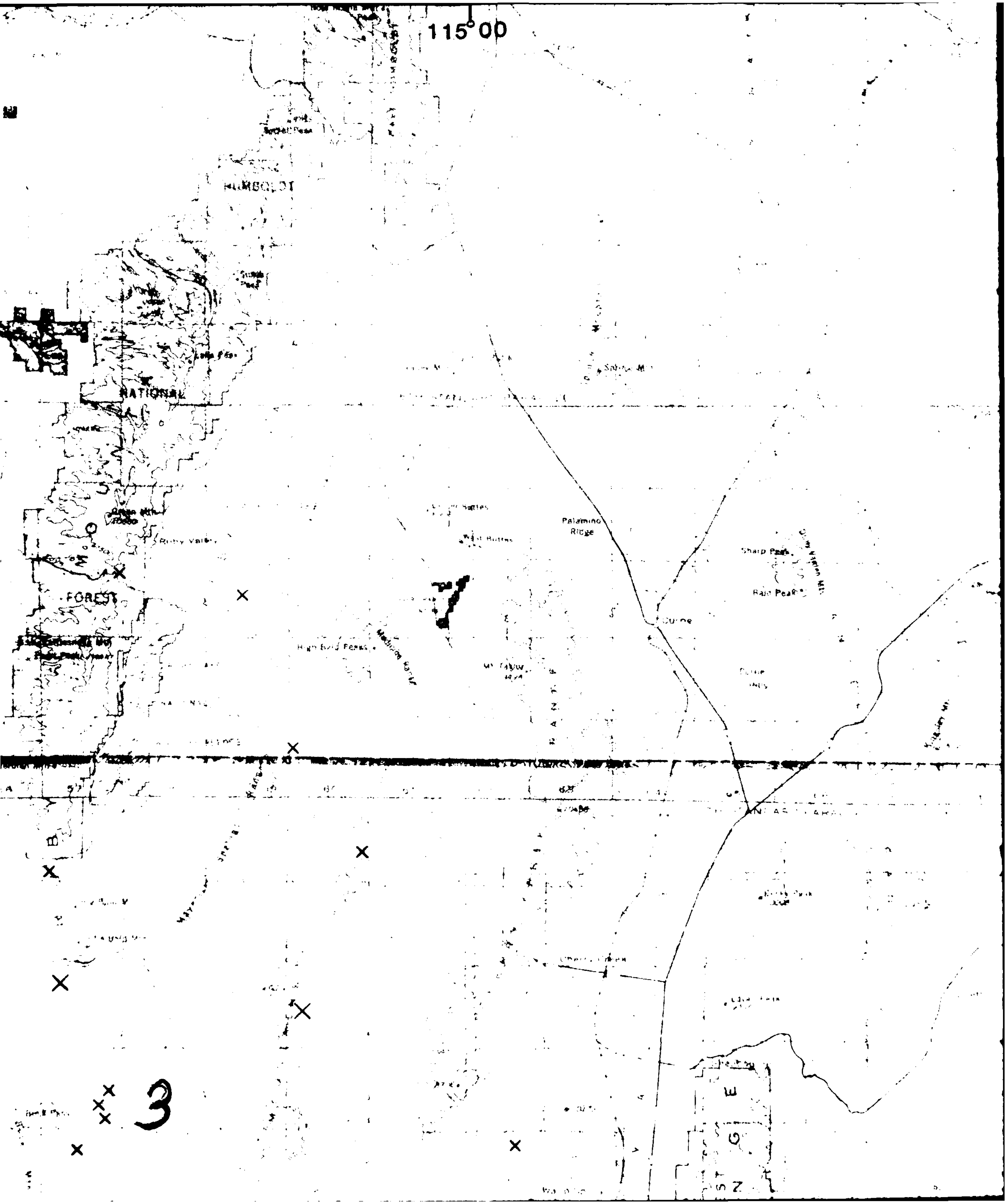
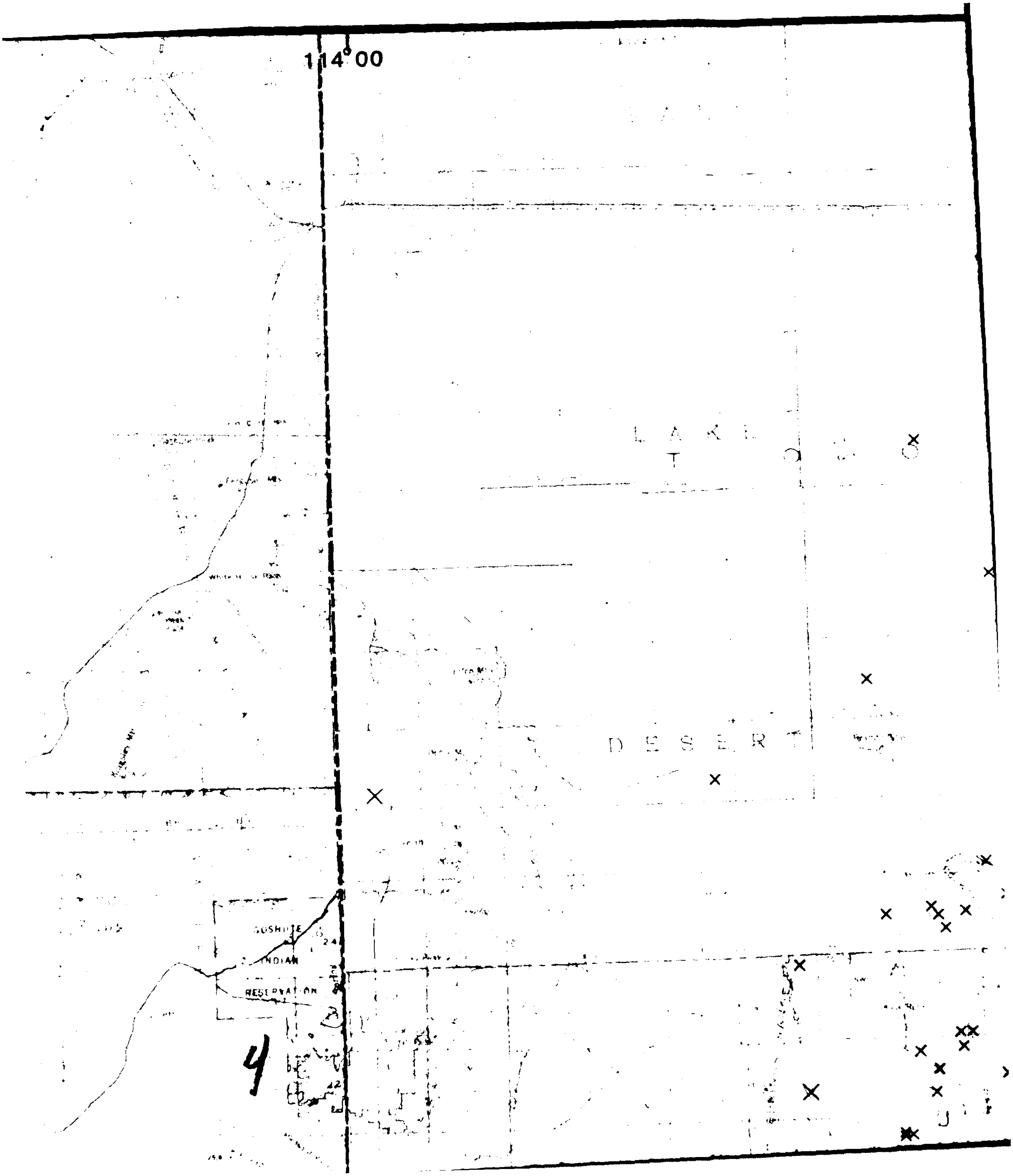
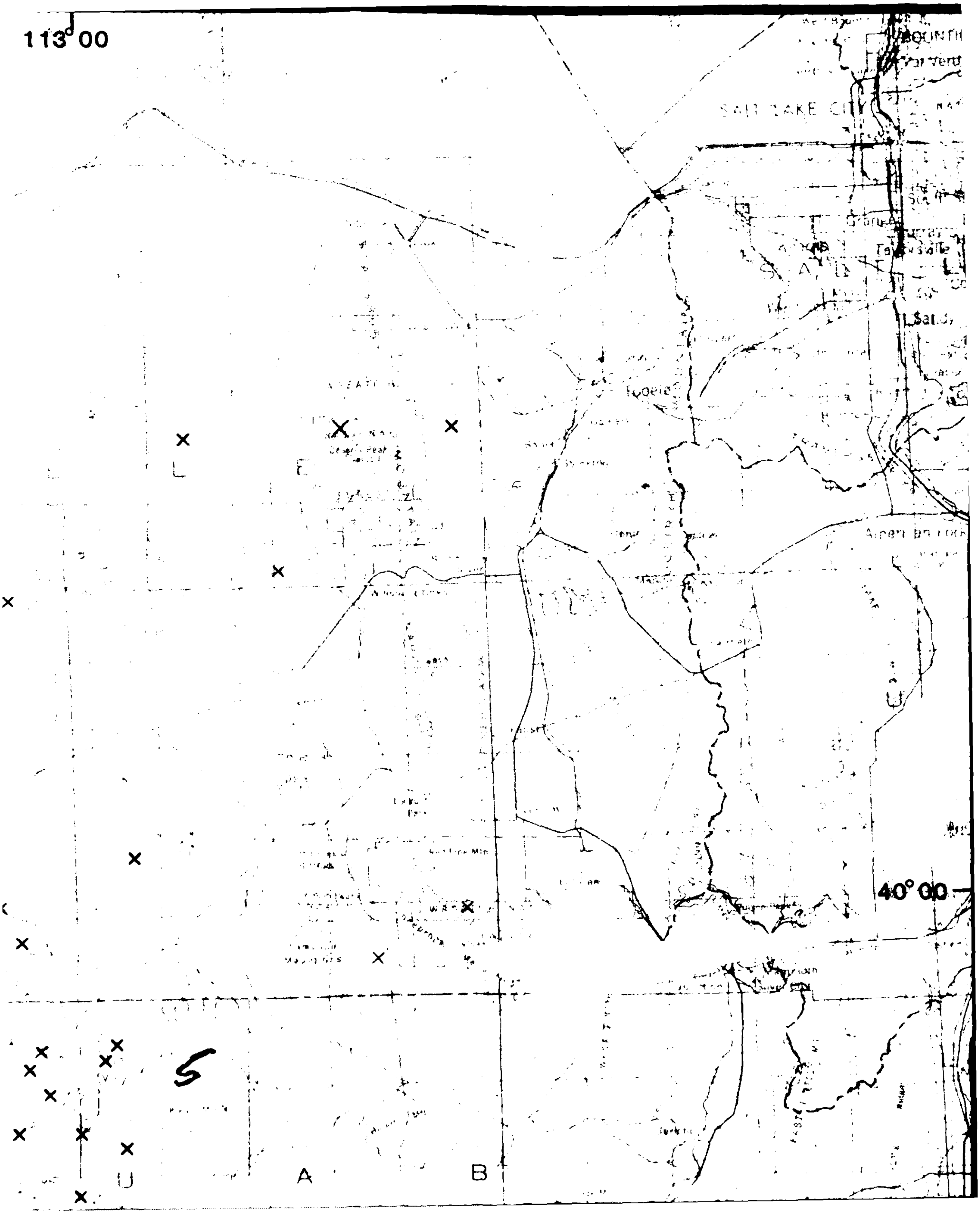
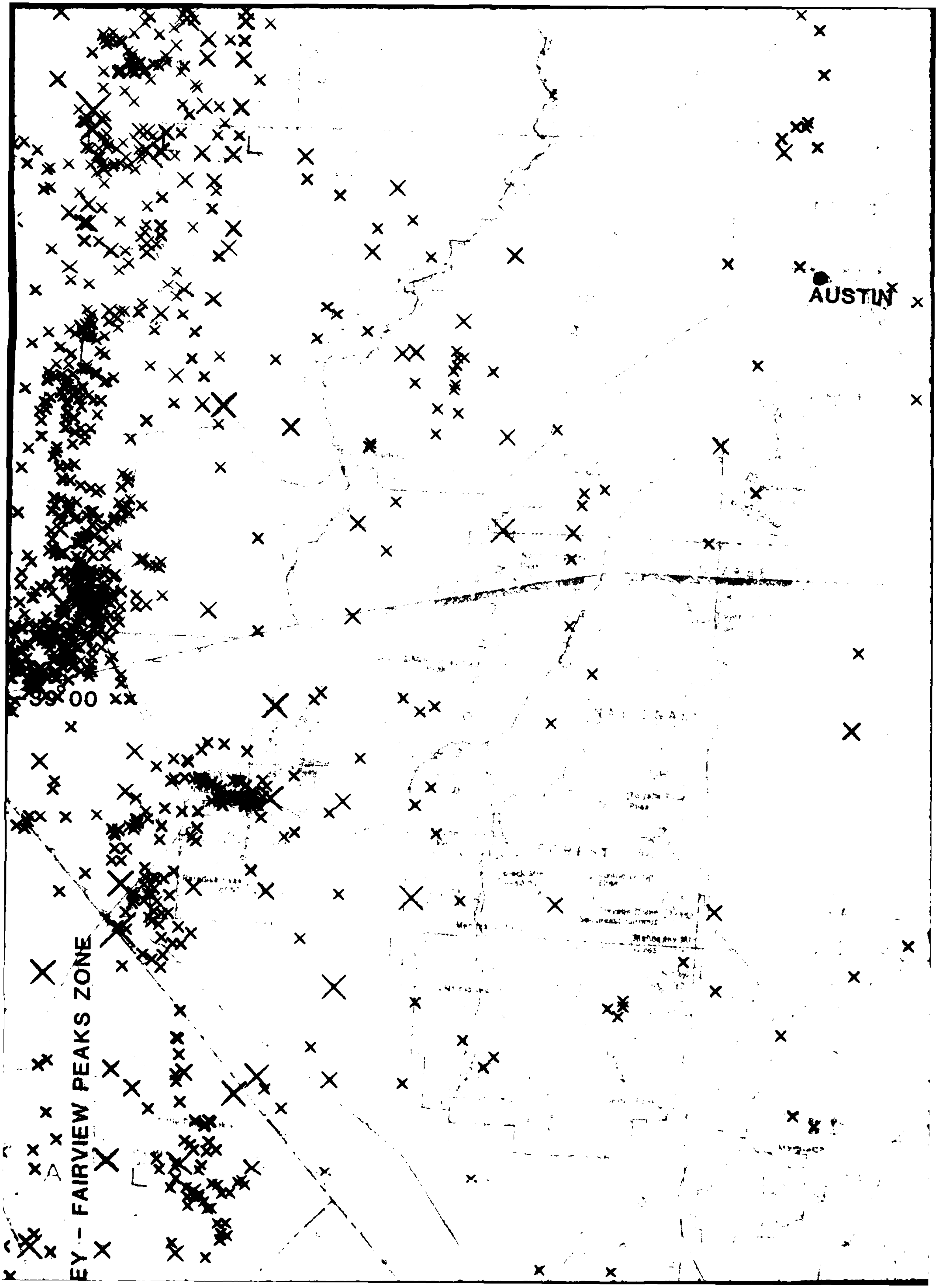
116°00
D E R
E U R E K A
Mt Tenabo
Cortez
2


115°00
HUMBOLDT
NATIONAL
FOREST
Palamino
Ridge
Sharp Peak
Currie
3


114°00
L A K E
D E S E R T
GOSHUTE
INDIAN
RESERVATION
4

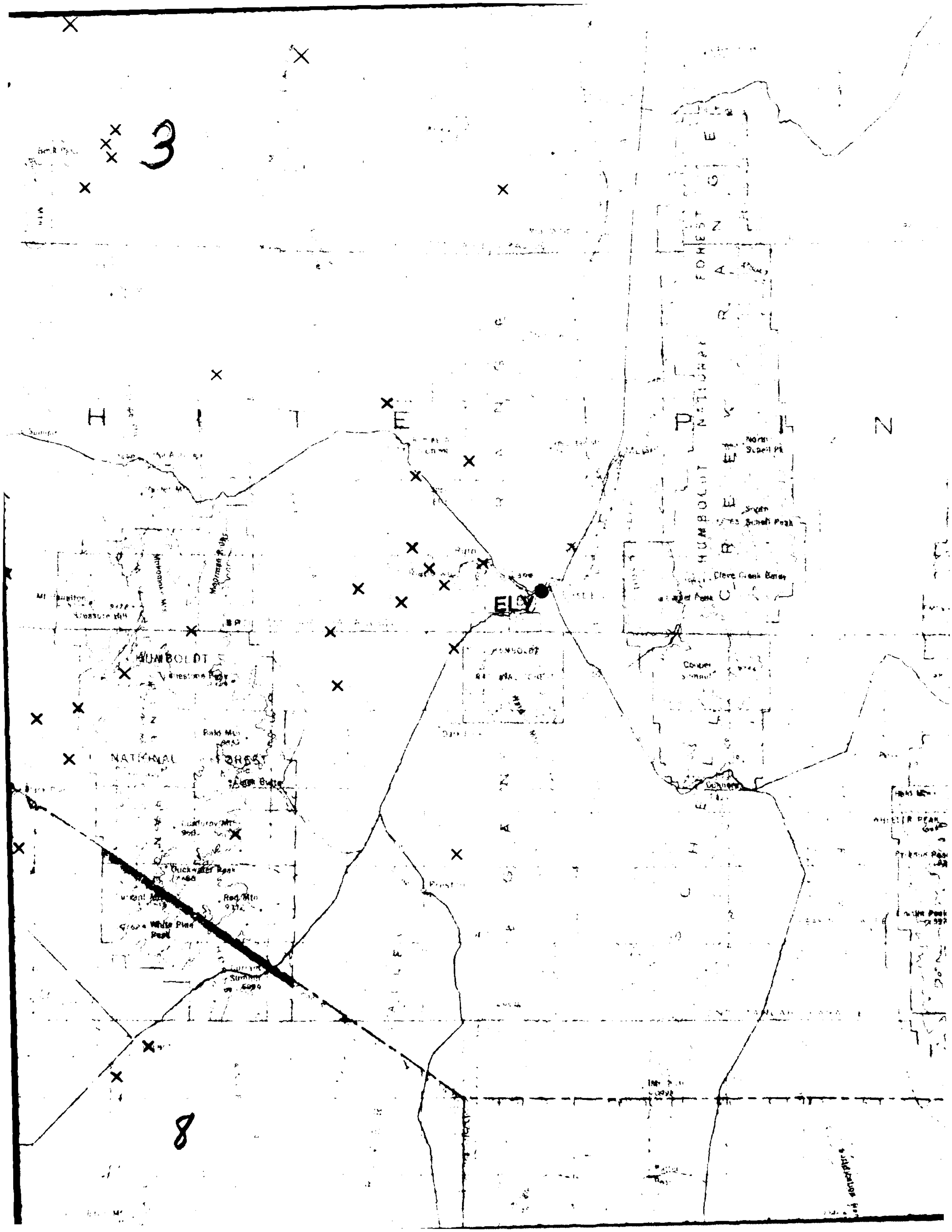


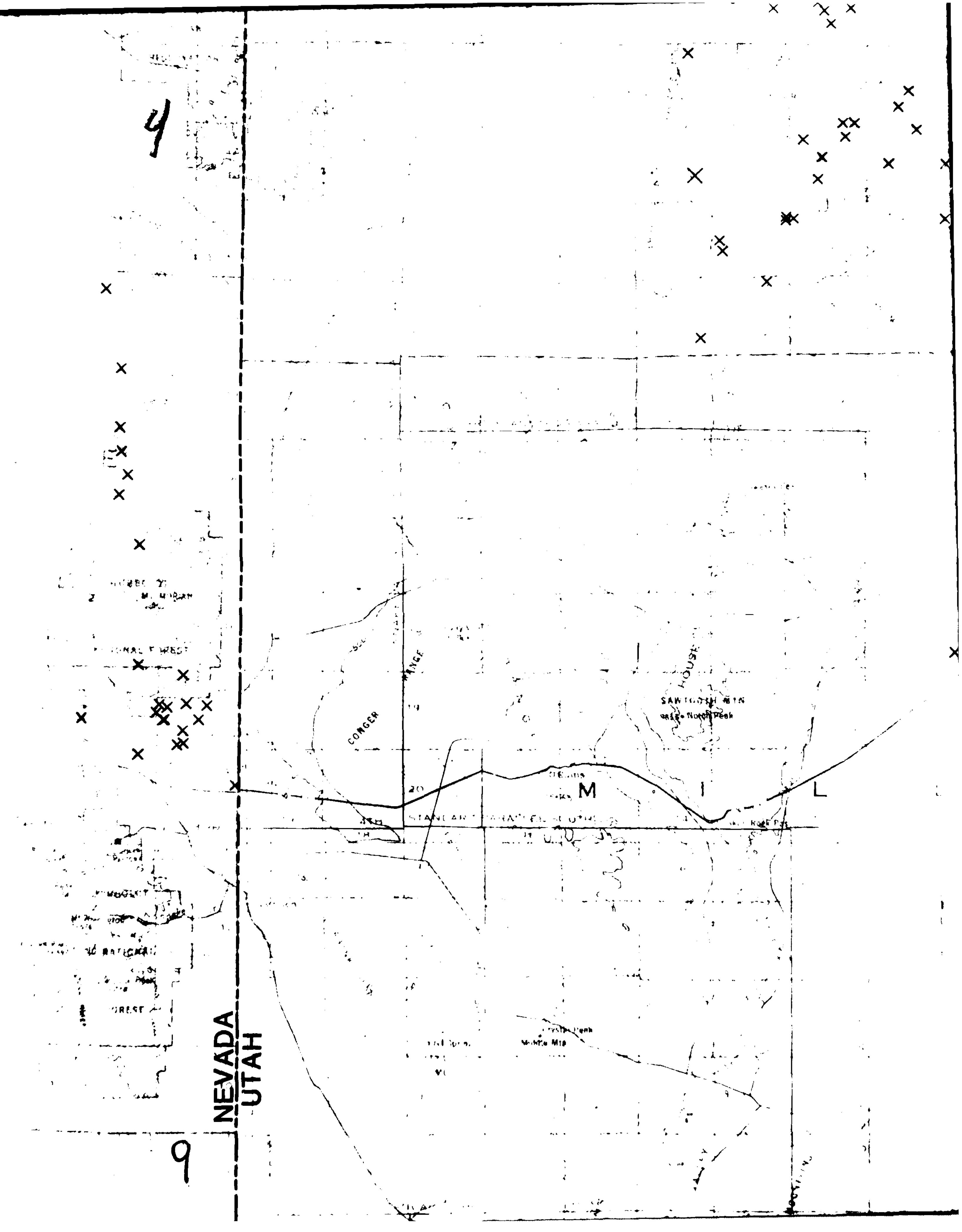
113°00
SALT LAKE CITY
Tooele
40°00
A
B
5

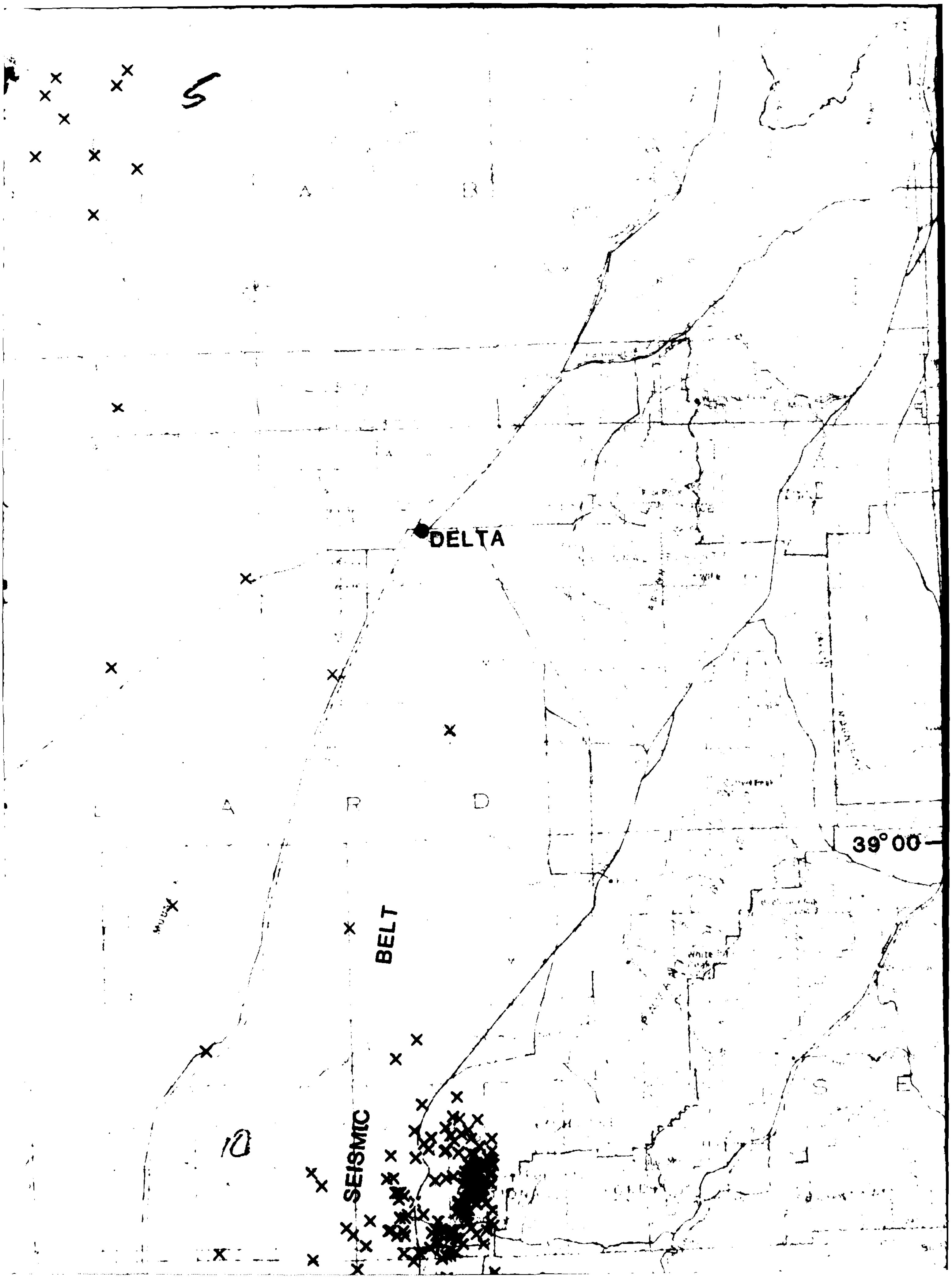


AUSTIN
39°00
EY - FAIRVIEW PEAKS ZONE

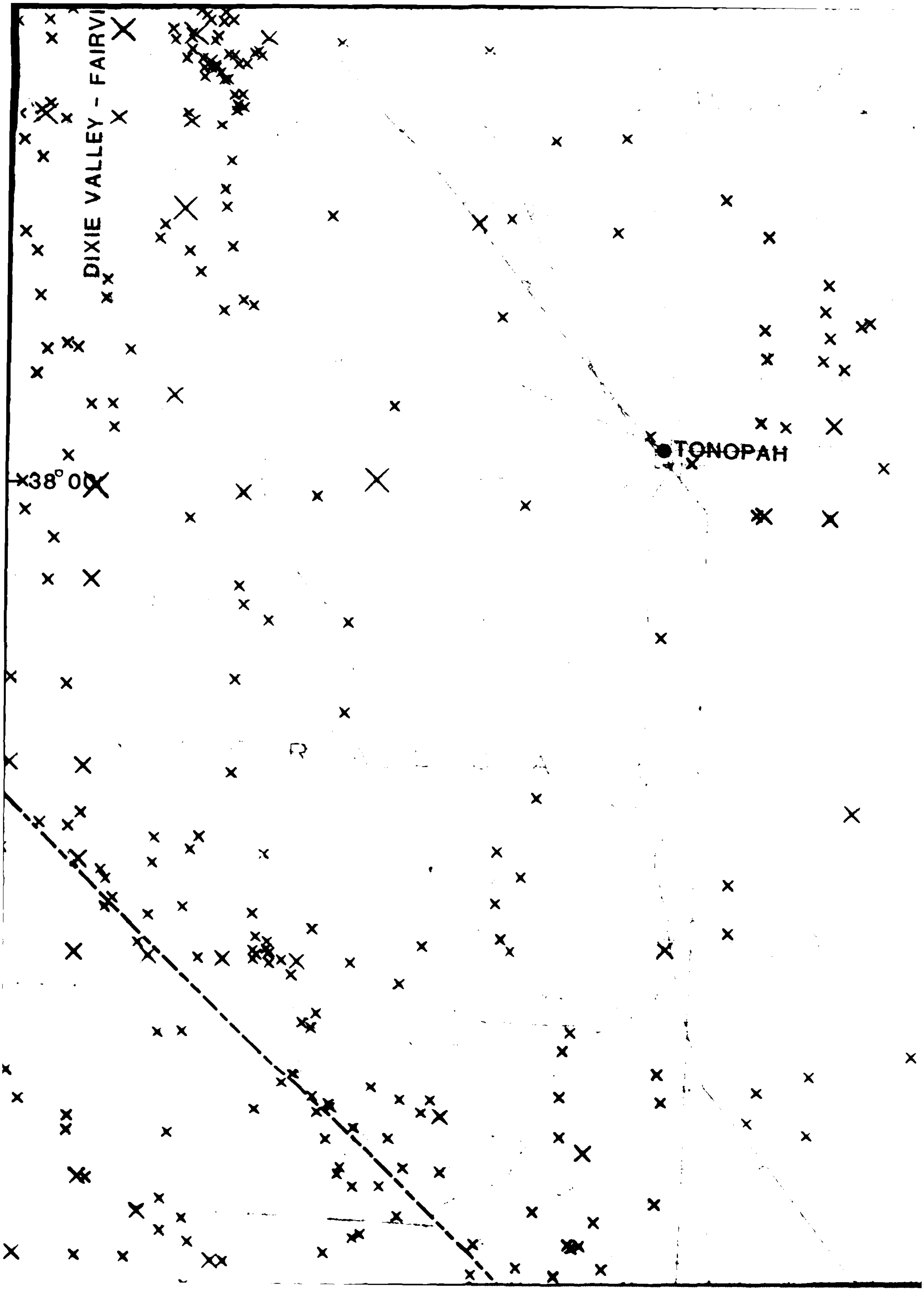
TIN
EUREKA
W
7

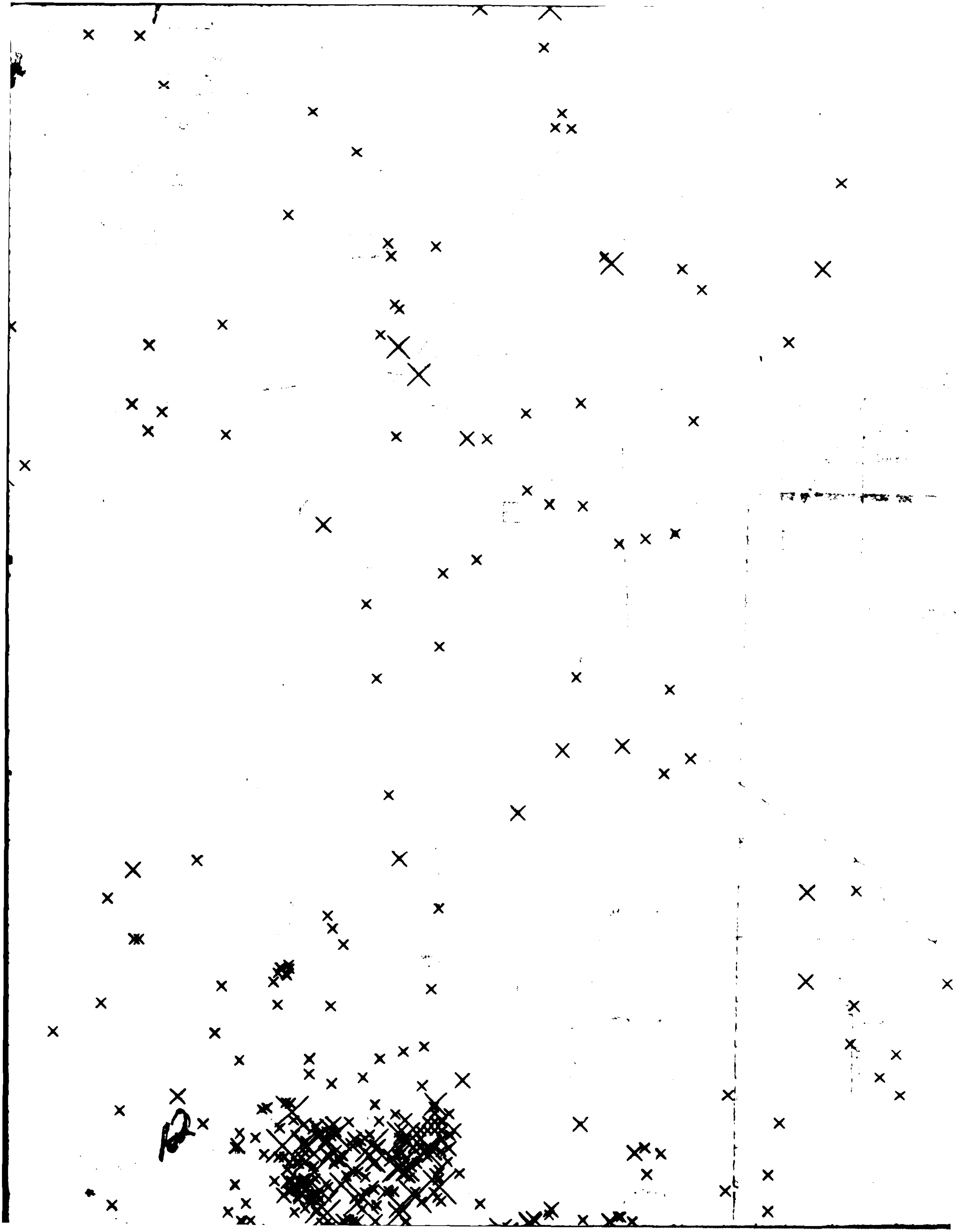

3
ELY
HUMBOLDT
NATIONAL FOREST
Bald Mtn
Duckwater Peak
Red Mtn
White Pine Peak
North Schell Pk
South Schell Peak
Cleve Creek Baldy
Connors
8

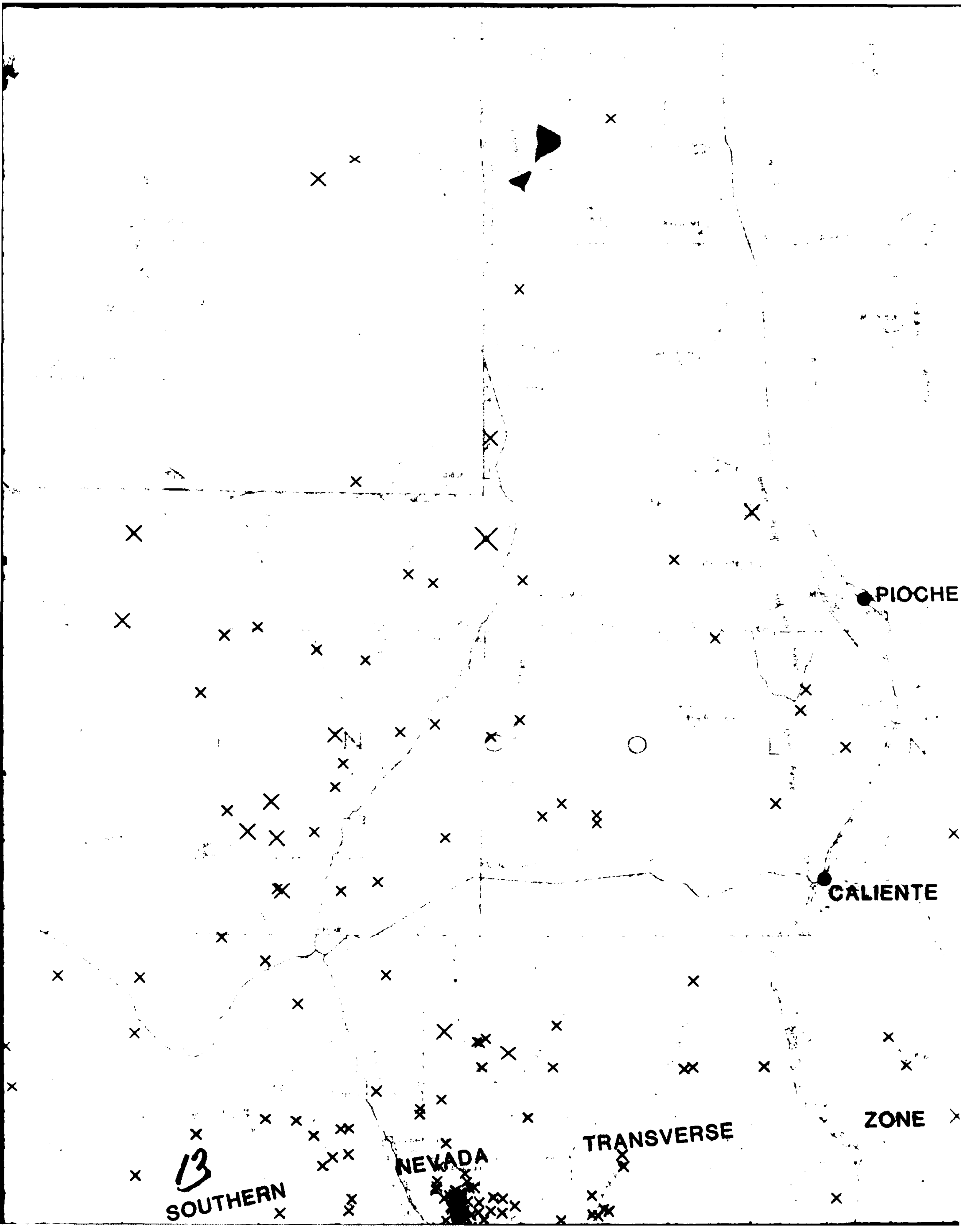

4
CONGER
RANGE
HOUSE
SAWTOOTH MTN
Notch Peak
M
I
L
NEVADA
UTAH
9



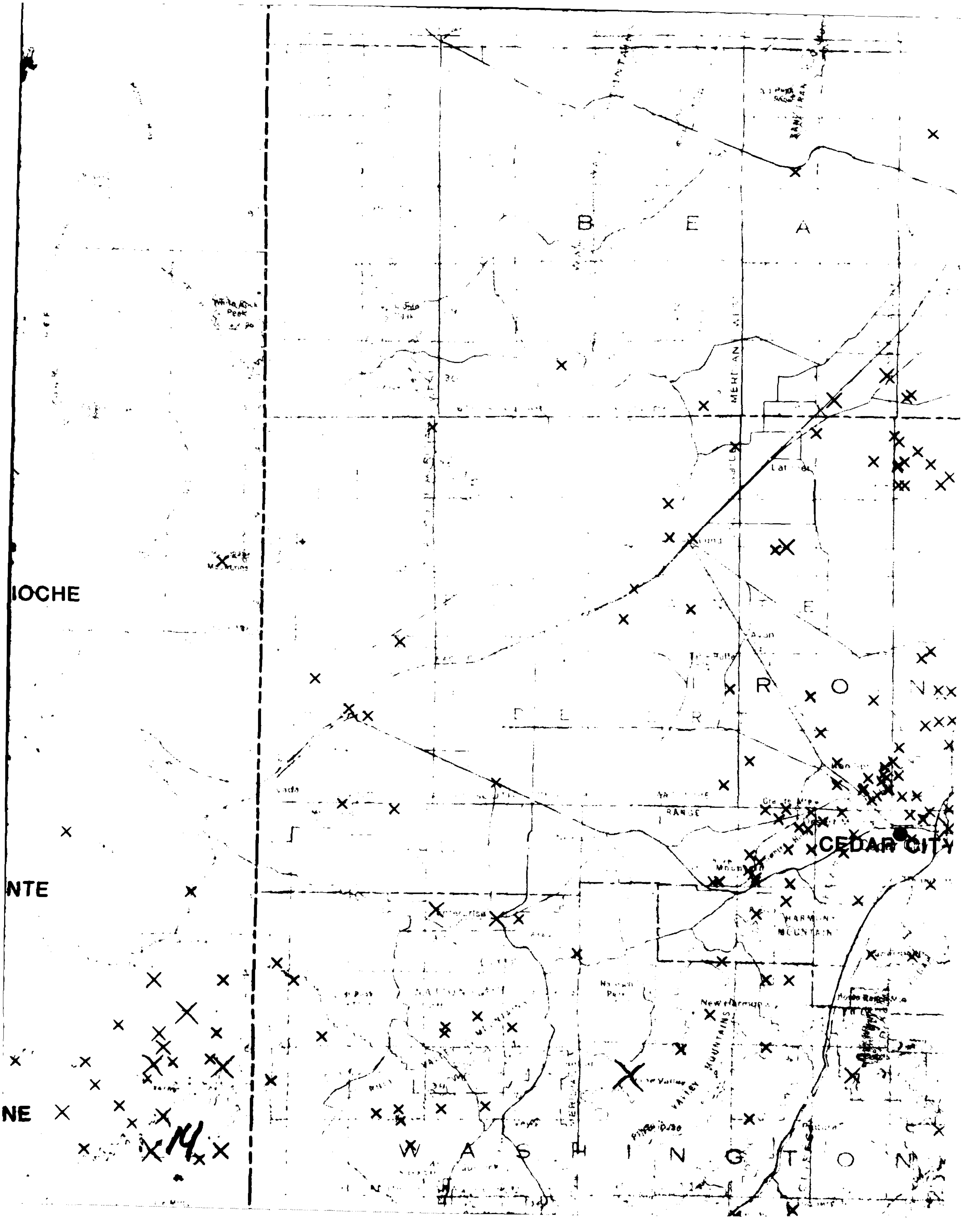
5
DELTA
39°00
BELT
SEISMIC
10


DIXIE VALLEY - FAIRVI
TONOPAH
38° 00'

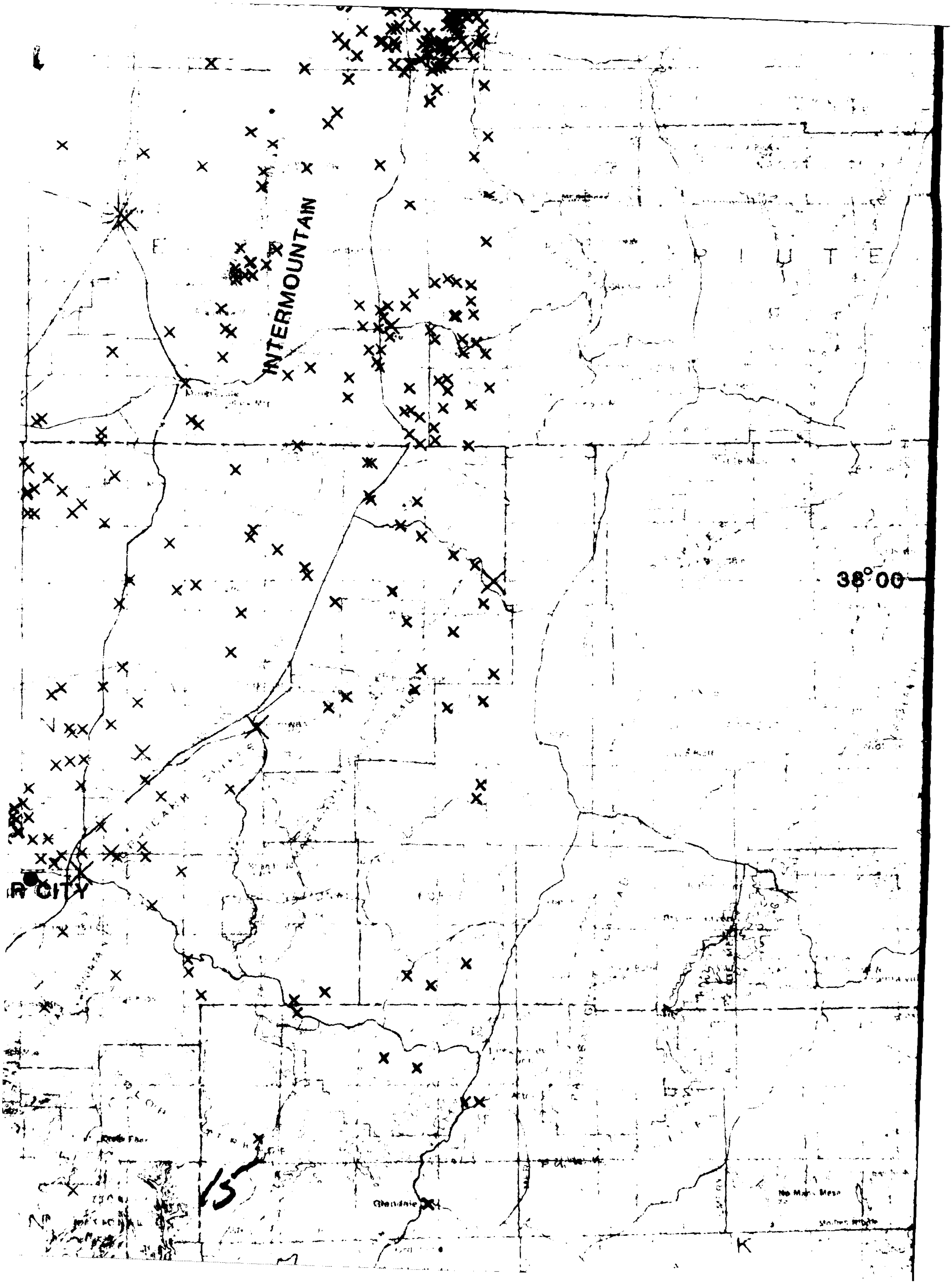


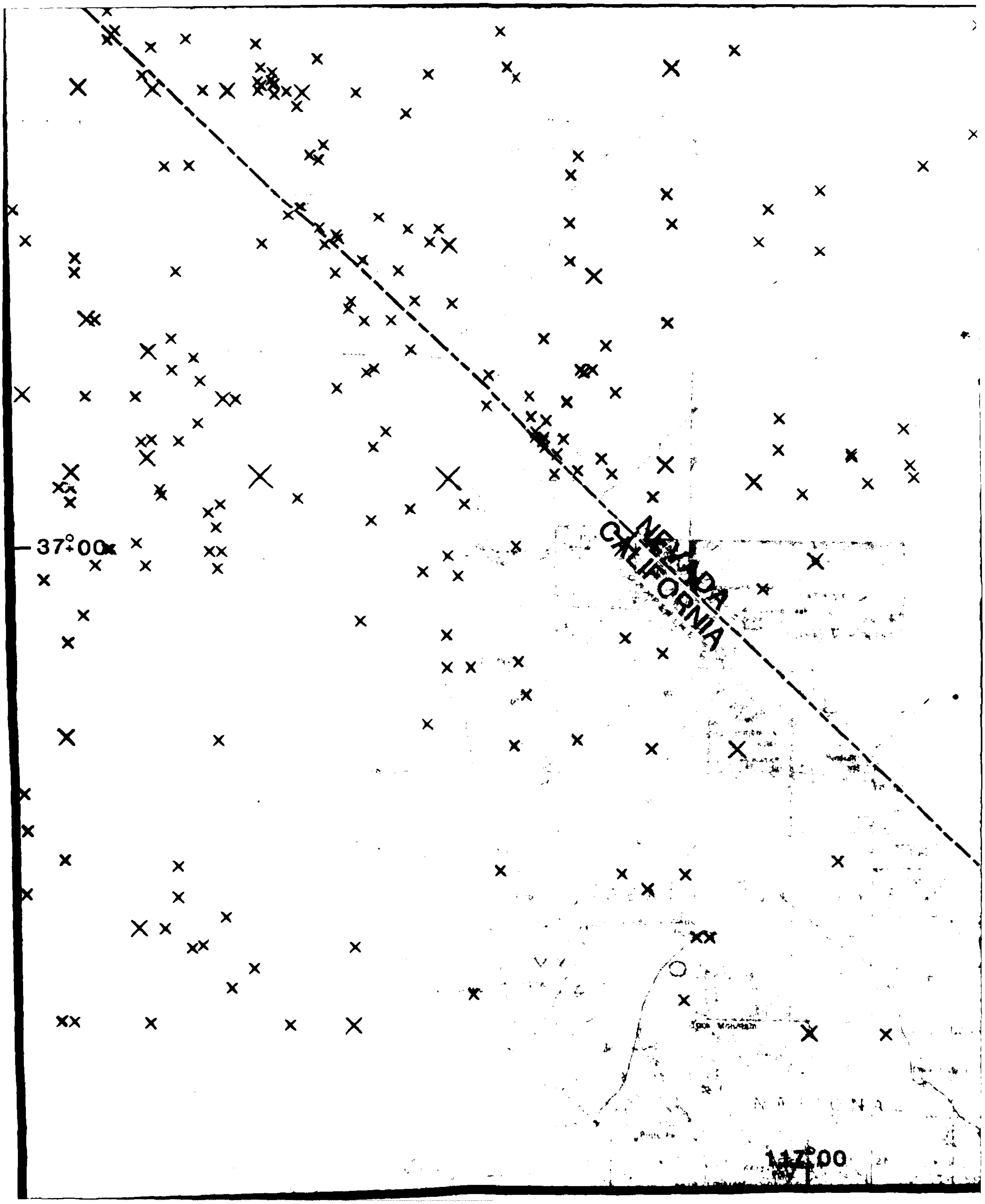


PIOCHE
CALIENTE
ZONE
TRANSVERSE
NEVADA
SOUTHERN
13

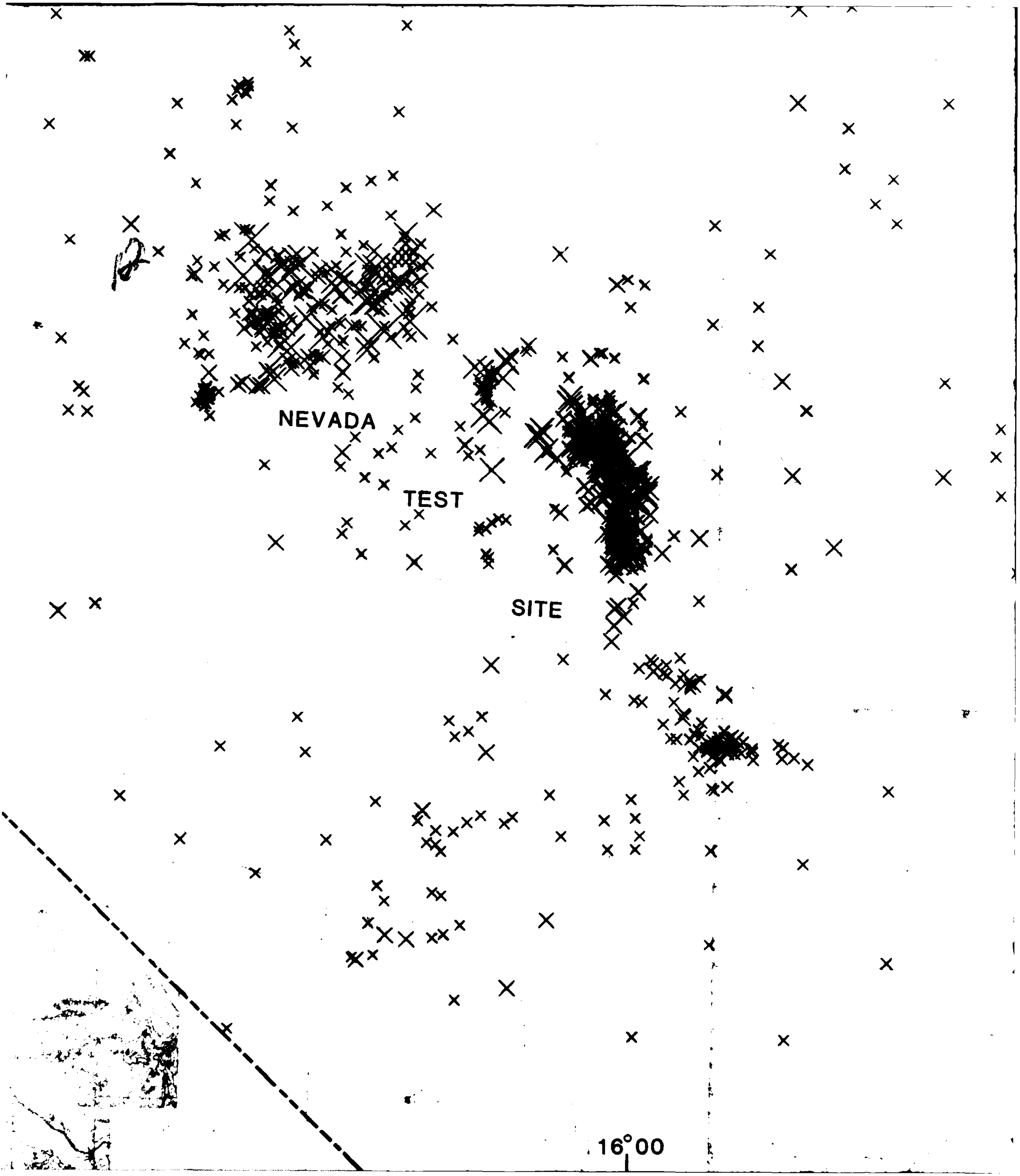


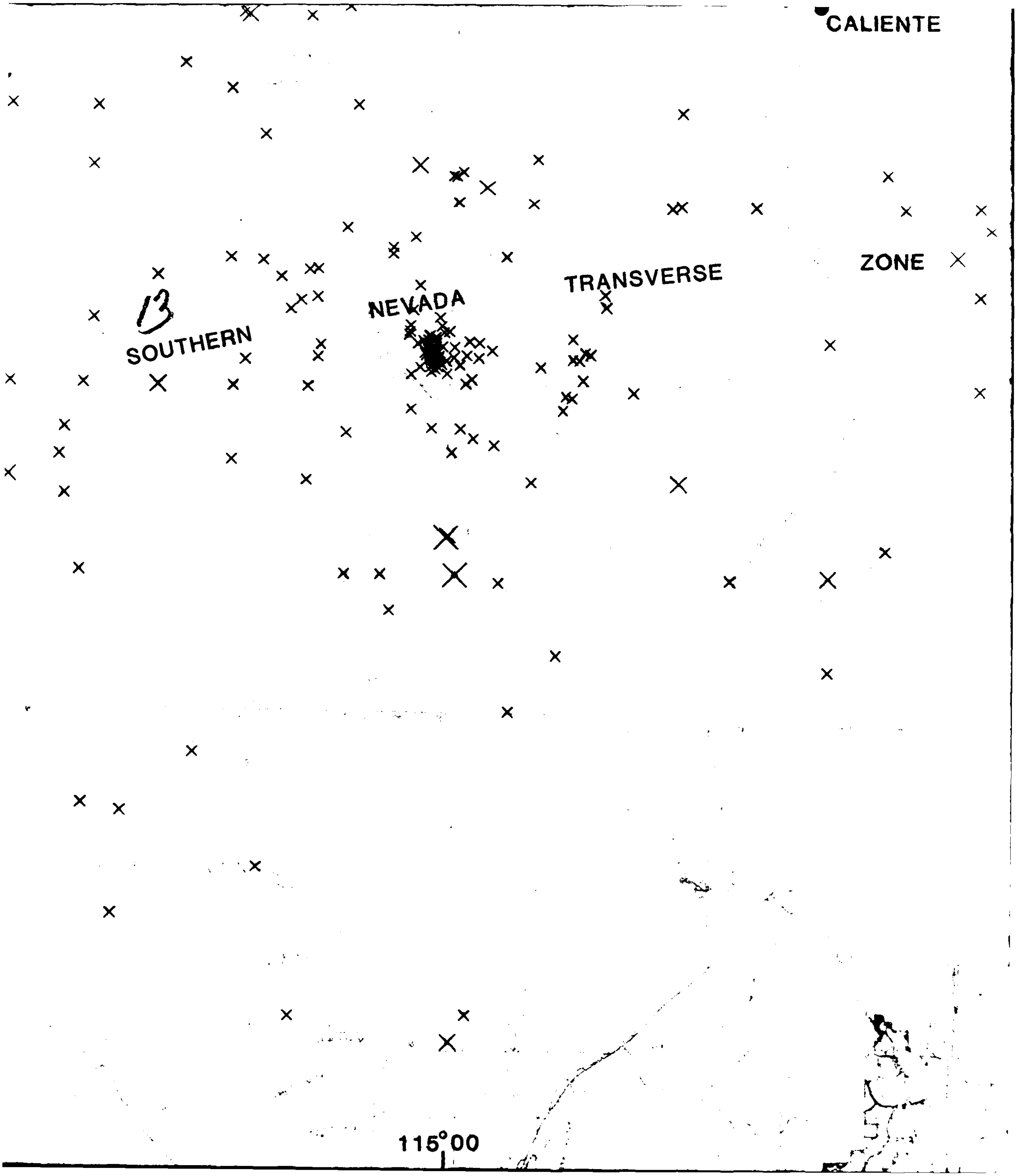
IOCHE
NTE
NE
B E A
I R O N
W A S H I N G T O N
CEDAR CITY
HARMONY MOUNTAINS
New Harmony
MOUNTAINS
VALLEY
Lund
Avon
White Rock Peak
RANGE


INTERMOUNTAIN
P I U T E
38°00'
R CITY
Glendale
No Mans Mesa
K

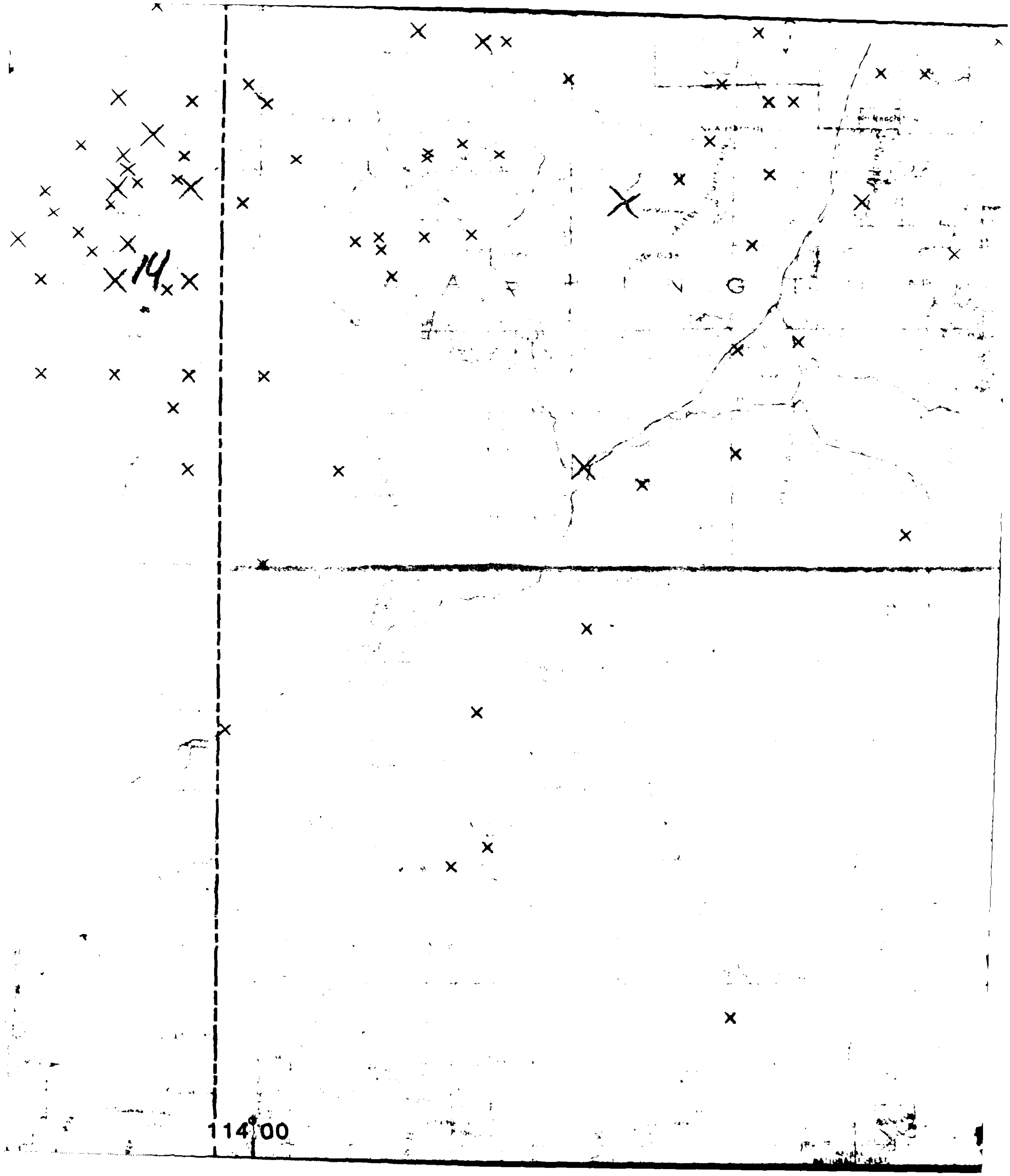


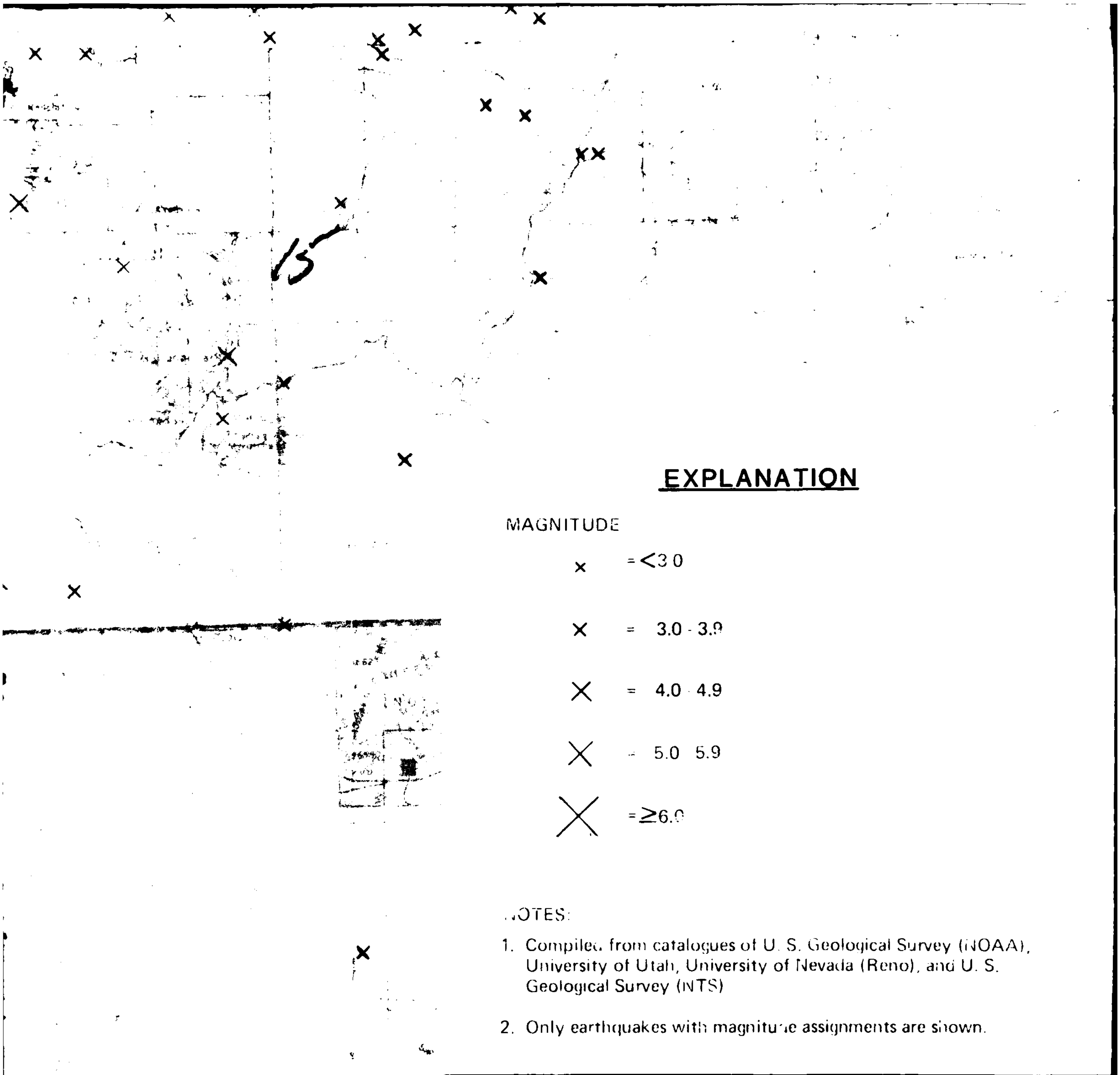
37°00
NEVADA
CALIFORNIA
117°00


NEVADA
TEST
SITE
16°00



13


14
A F T I N G
114°00



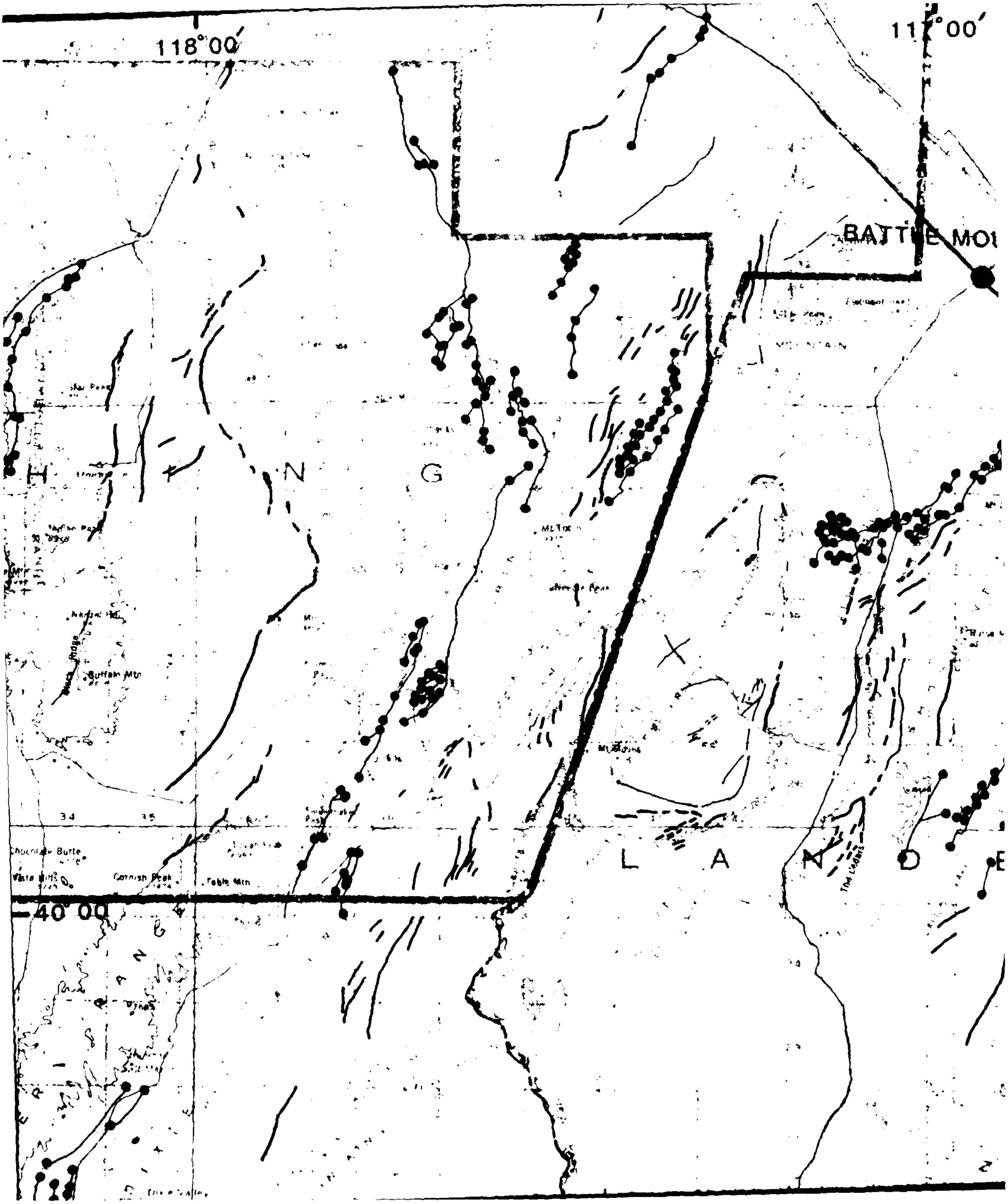
NEVADA-UTAH STUDY AREA
EARTHQUAKE EPICENTERS

MX SITING INVESTIGATION

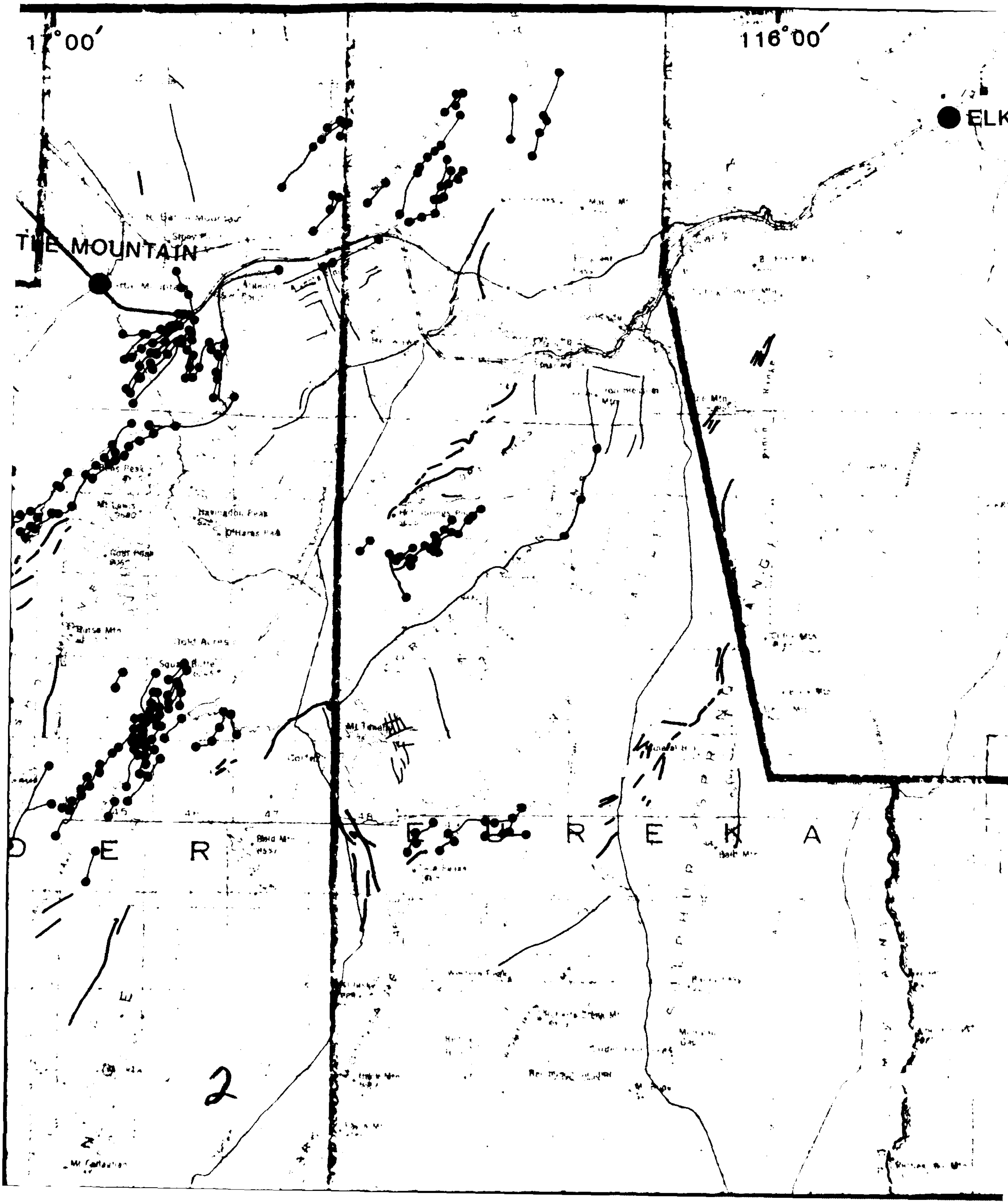
DEPARTMENT OF THE AIR FORCE - BMO

DRAWING **10-1**

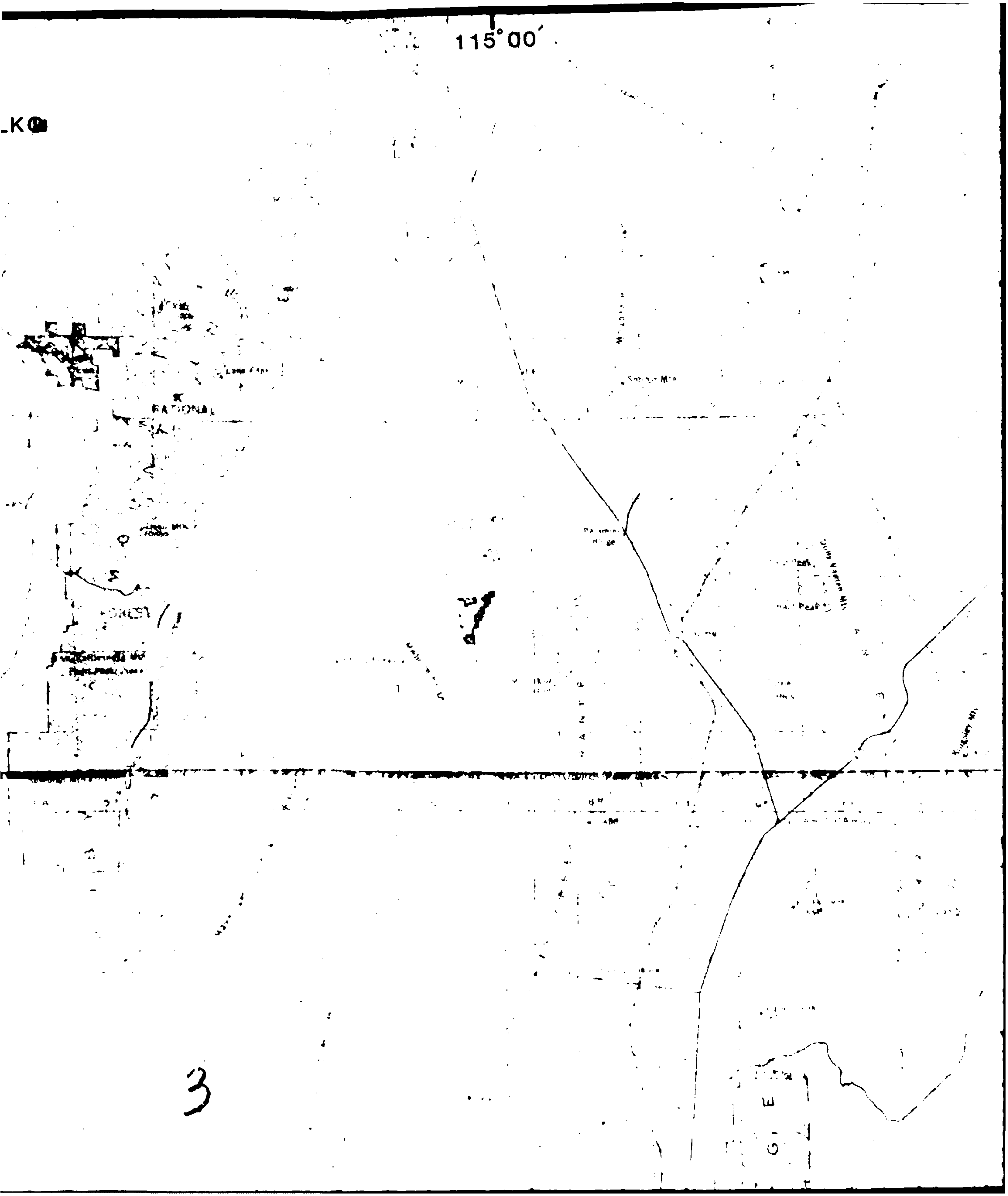
FUGRO NATIONAL, INC.



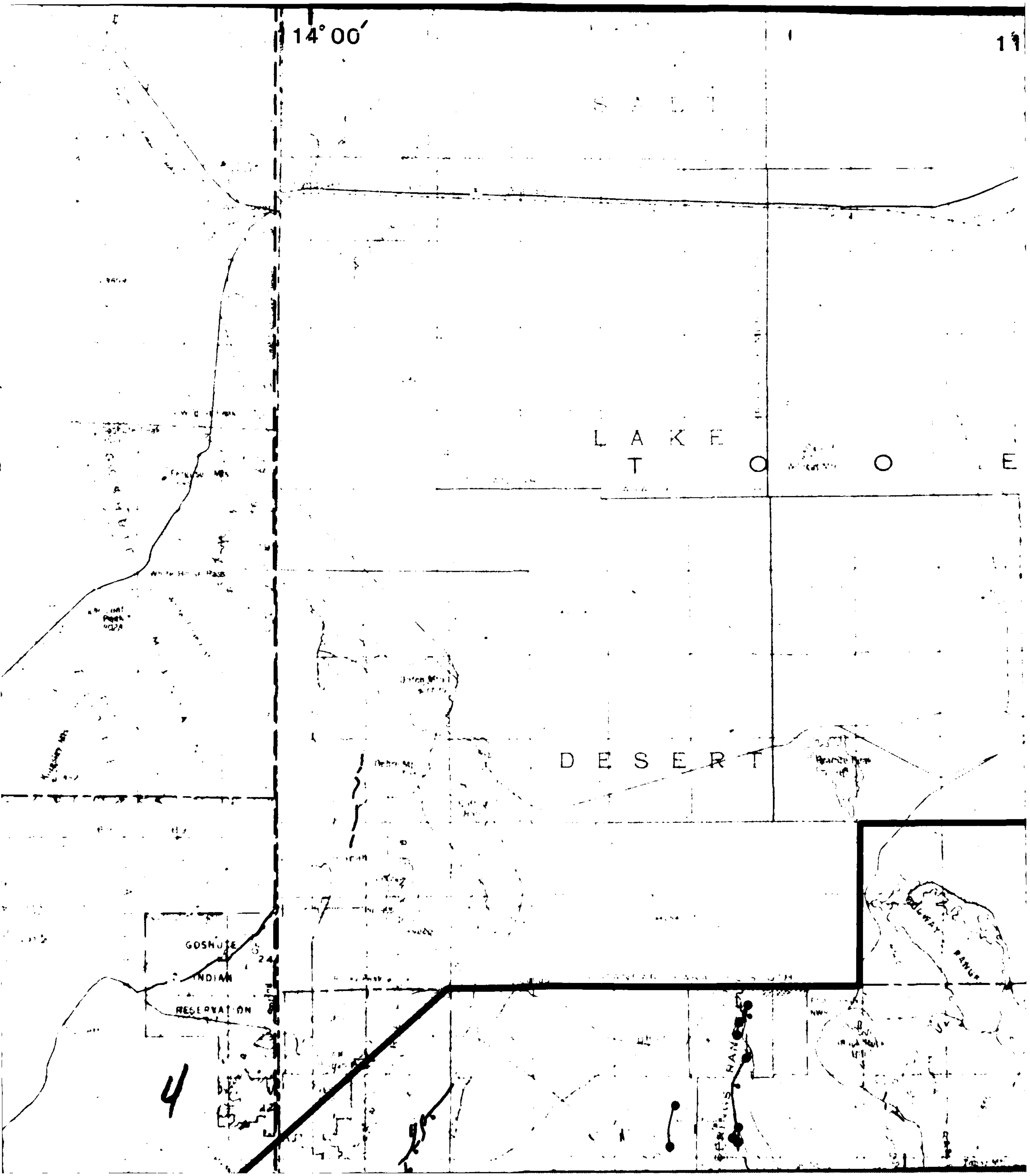
118°00′
117°00′
BATTLE MOU
40°00′
H
N
G
X
L
A
N
D
E
Buffalo Mtn
Chocolate Butte
Table Mtn
Cornish Peak



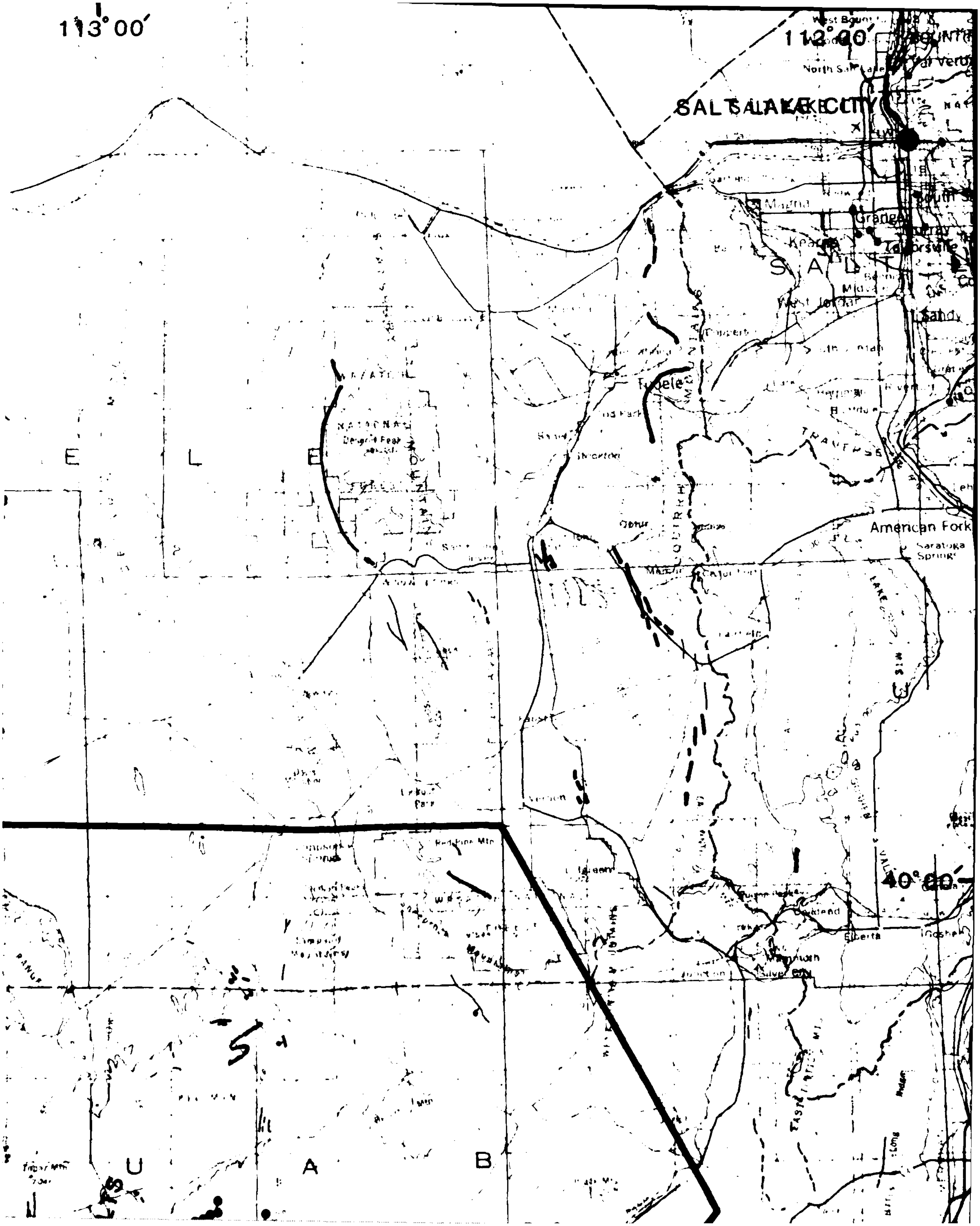
117°00′
116°00′
ELKO
TLE MOUNTAIN
E U R E K A
D E R
2



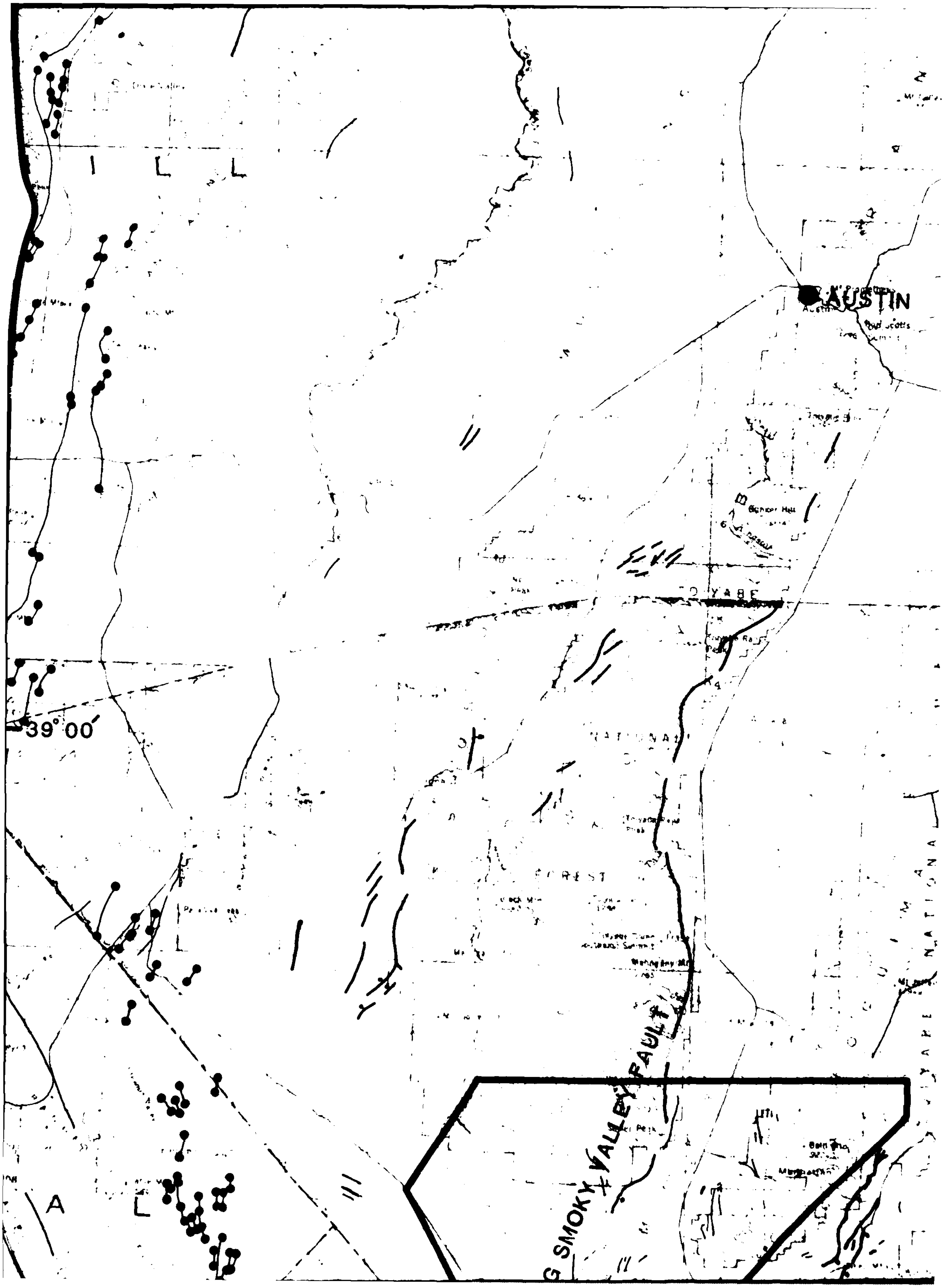
3

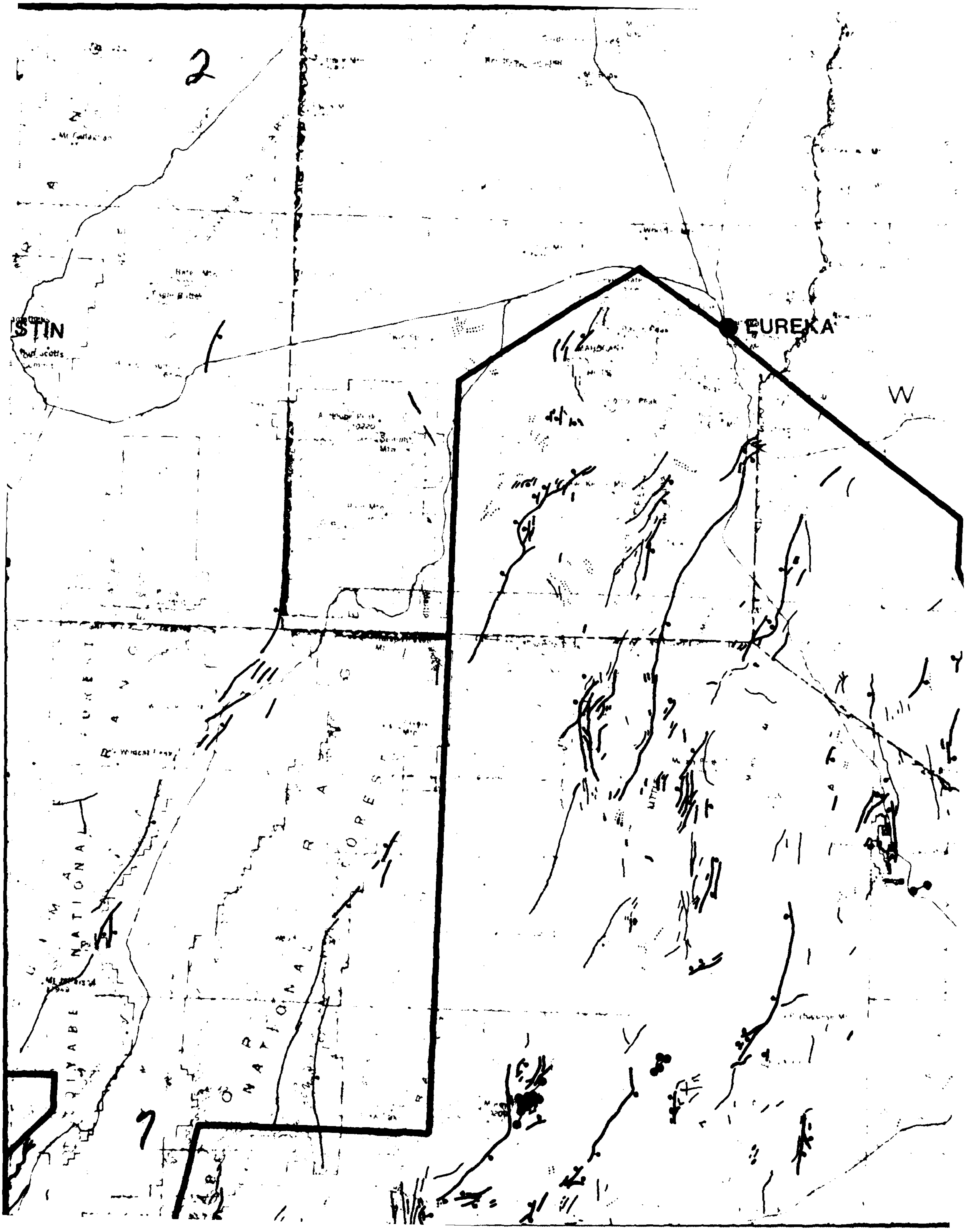


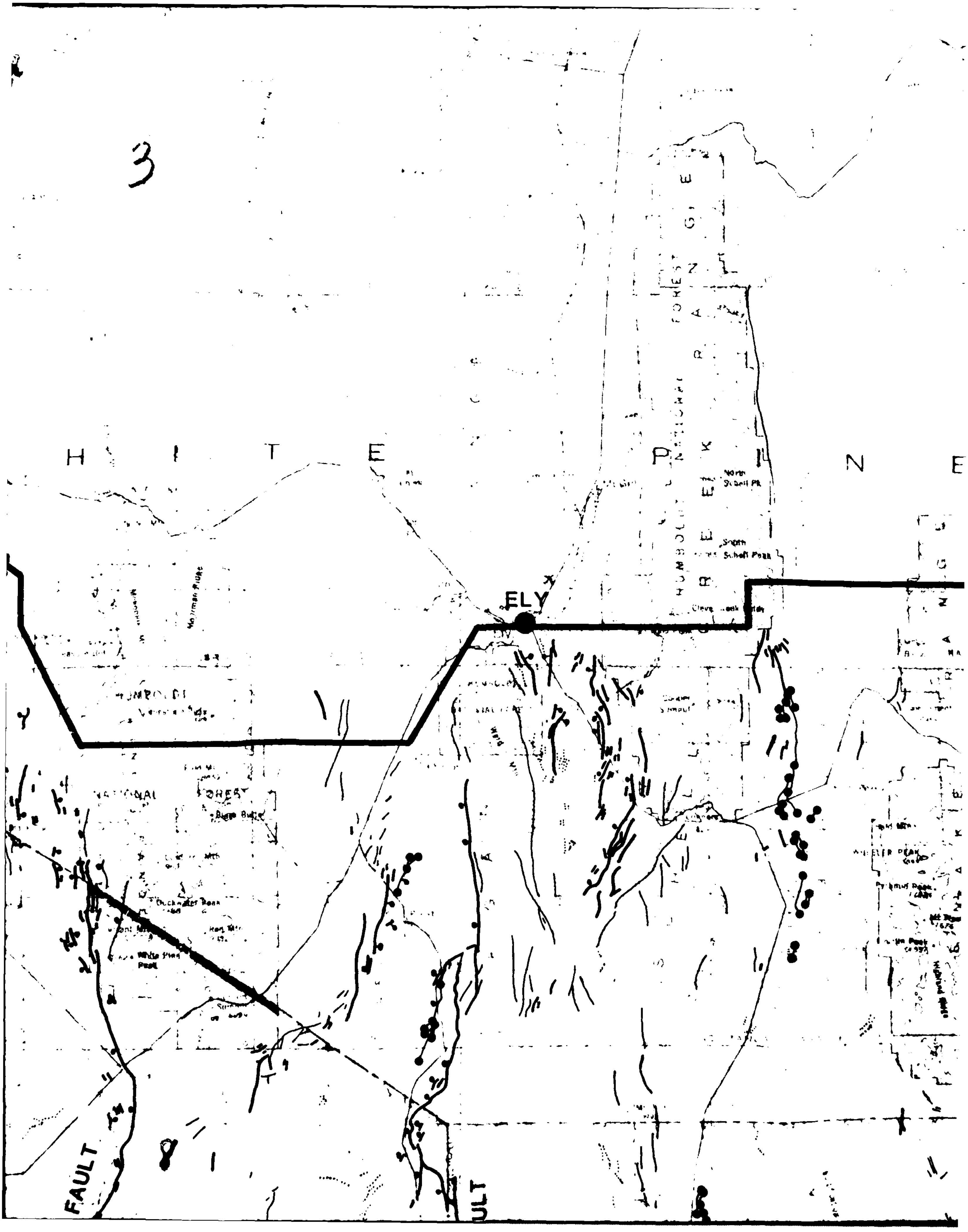
14° 00′
LAKE
T O O E
DESERT
GOSHUTE
INDIAN
RESERVATION
4

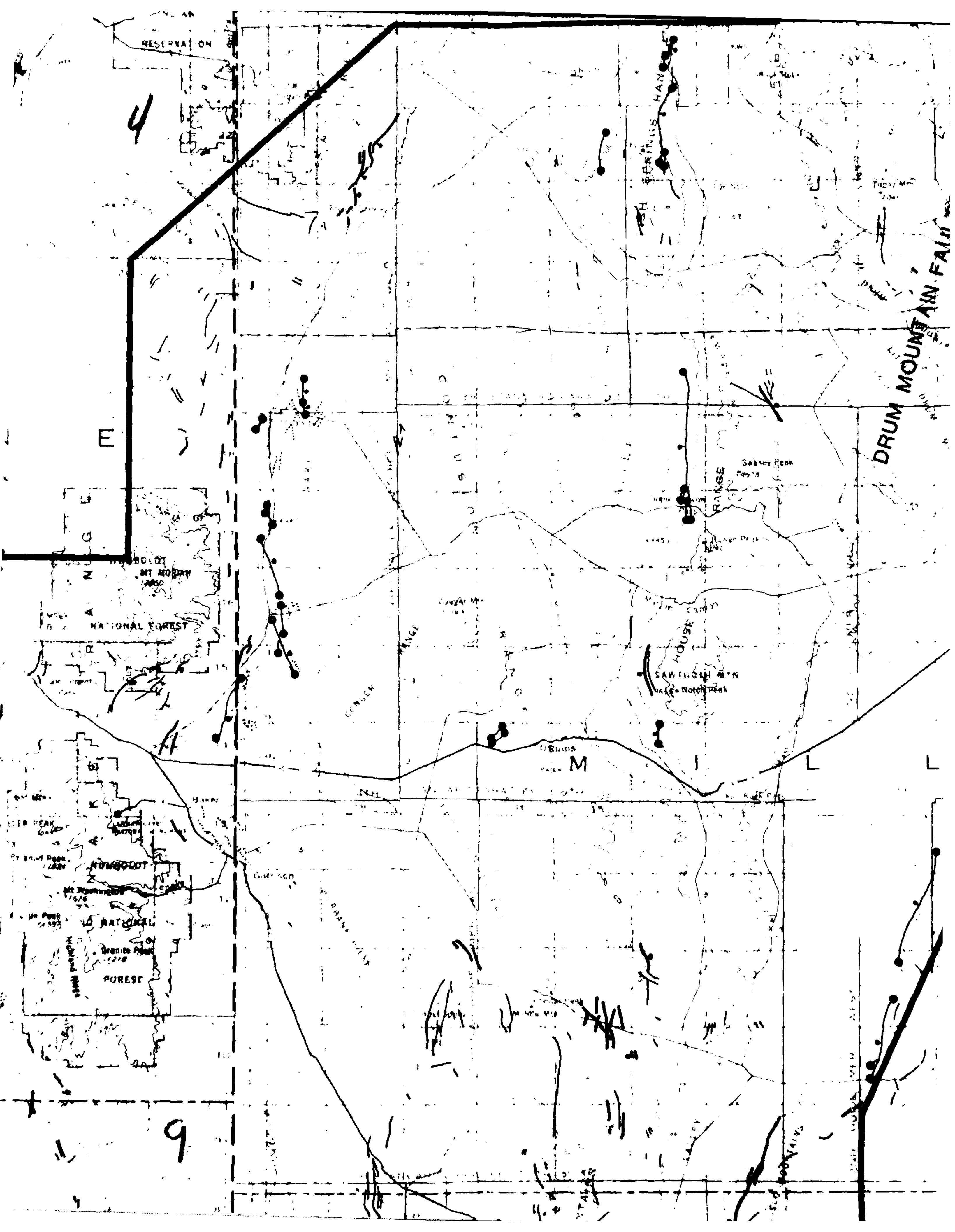


113°00′
112°00′
North Salt Lake
SALT LAKE CITY
Magna
Grange
Kearns
Taylorsville
West Jordan
Sandy
Tooele
TRAVERSE
American Fork
Saratoga Springs
40°00′
Elberta
Goshen
Mammoth
Silver City
E L E
S A L T
U A B

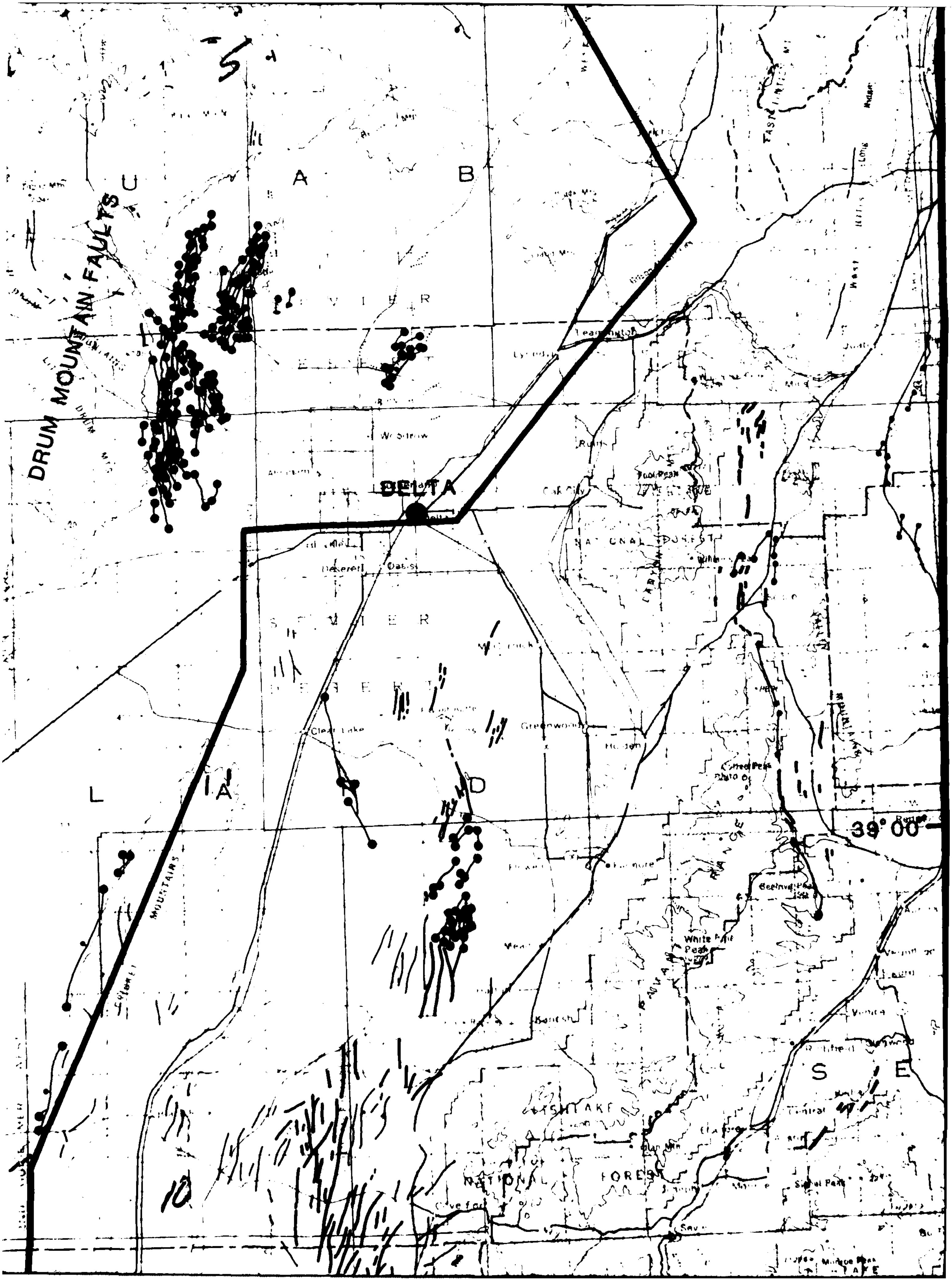

AUSTIN
39°00′
G SMOKY VALLEY FAULT
TOYABE
FOREST

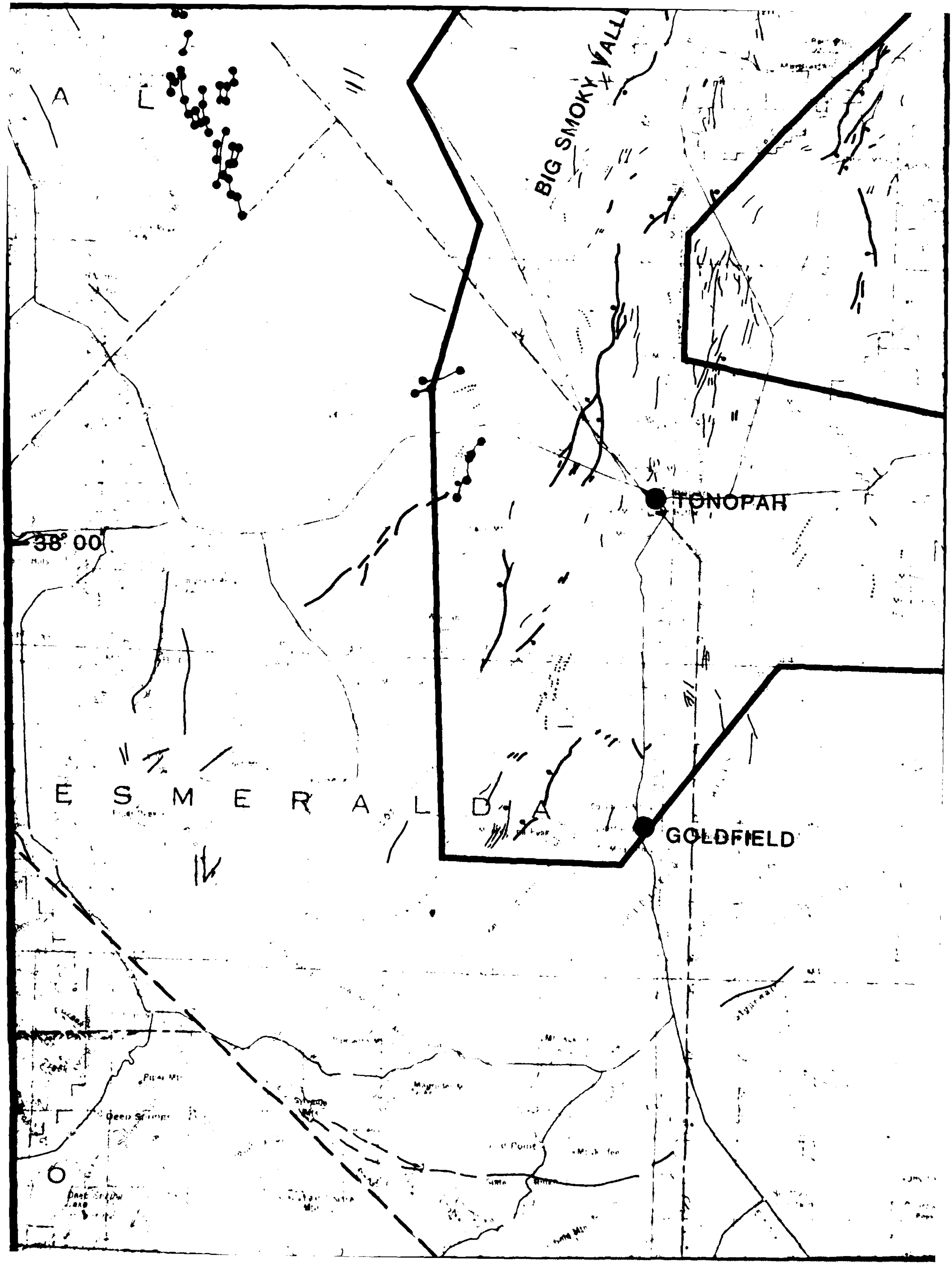

2
STIN
EUREKA
W
NATIONAL
FOREST
7


3
H I T E P N E
ELY
North Schell Pk
South Schell Peak
HUMBOLDT
NATIONAL
Duckwater Peak
White Pine Peak
WHEELER PEAK
FAULT
ULT

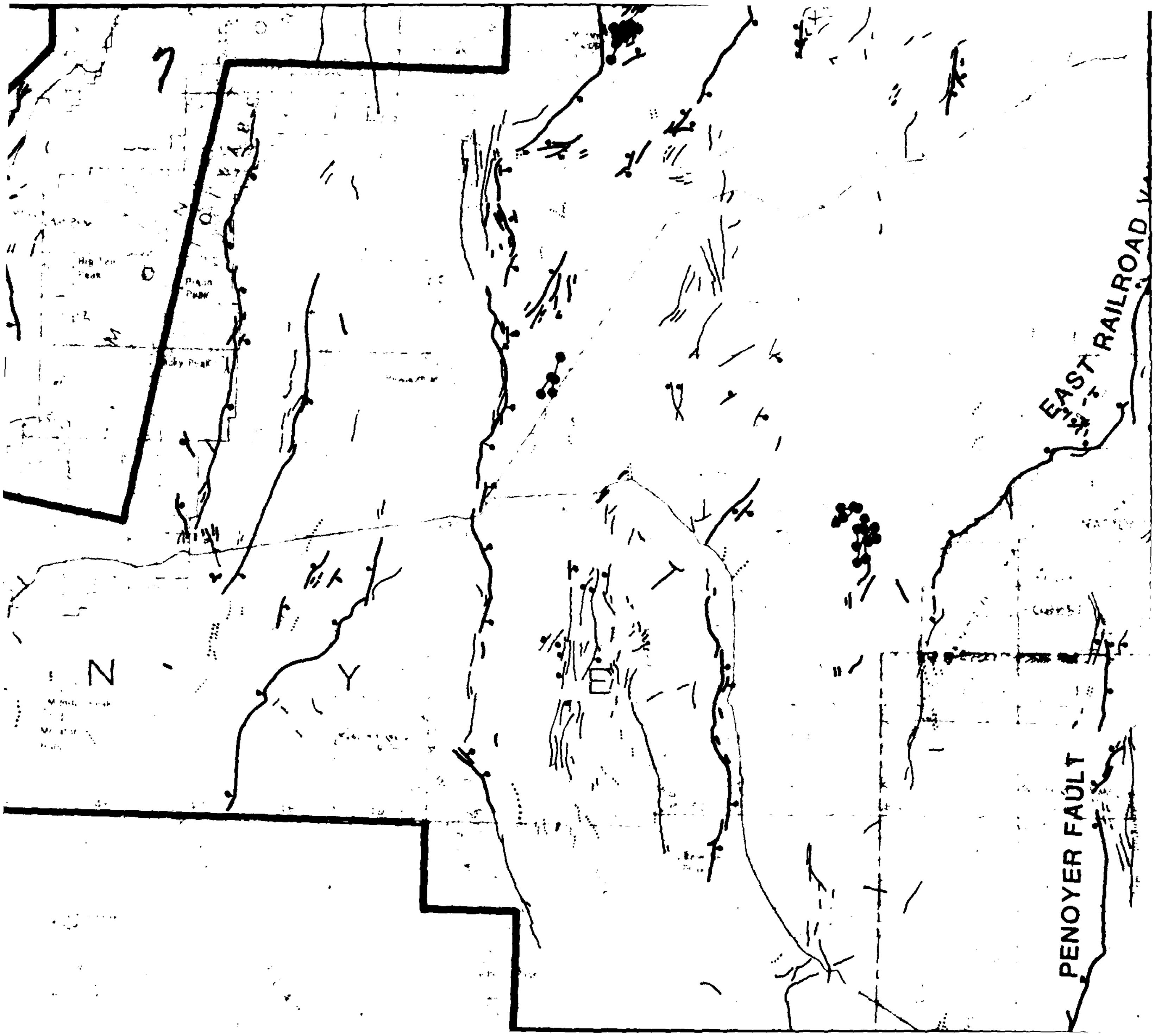


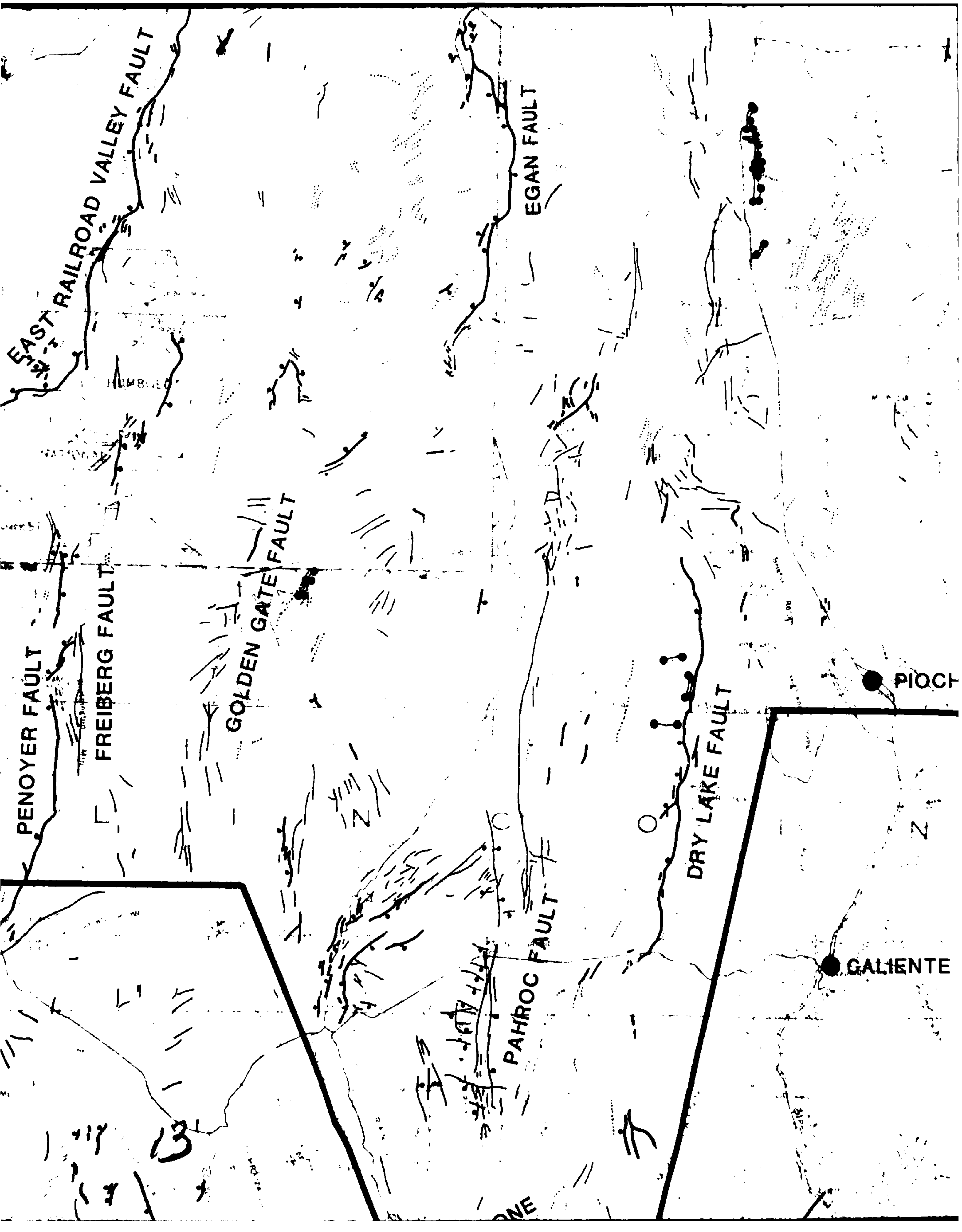
RESERVATION
4
E
HUMBOLDT
MT MORIAH
NATIONAL FOREST
Baker
HUMBOLDT
NATIONAL
FOREST
Garrison
9
DRUM MOUNTAIN FAU
Swasey Peak
RANGE
HOUSE
SAWTOOTH MTN
Notch Peak
CONGER
RANGE
M
I
L
L


DRUM MOUNTAIN FAULTS
DELTA
39° 00'
U A B
S E V I E R
L A R D
S E

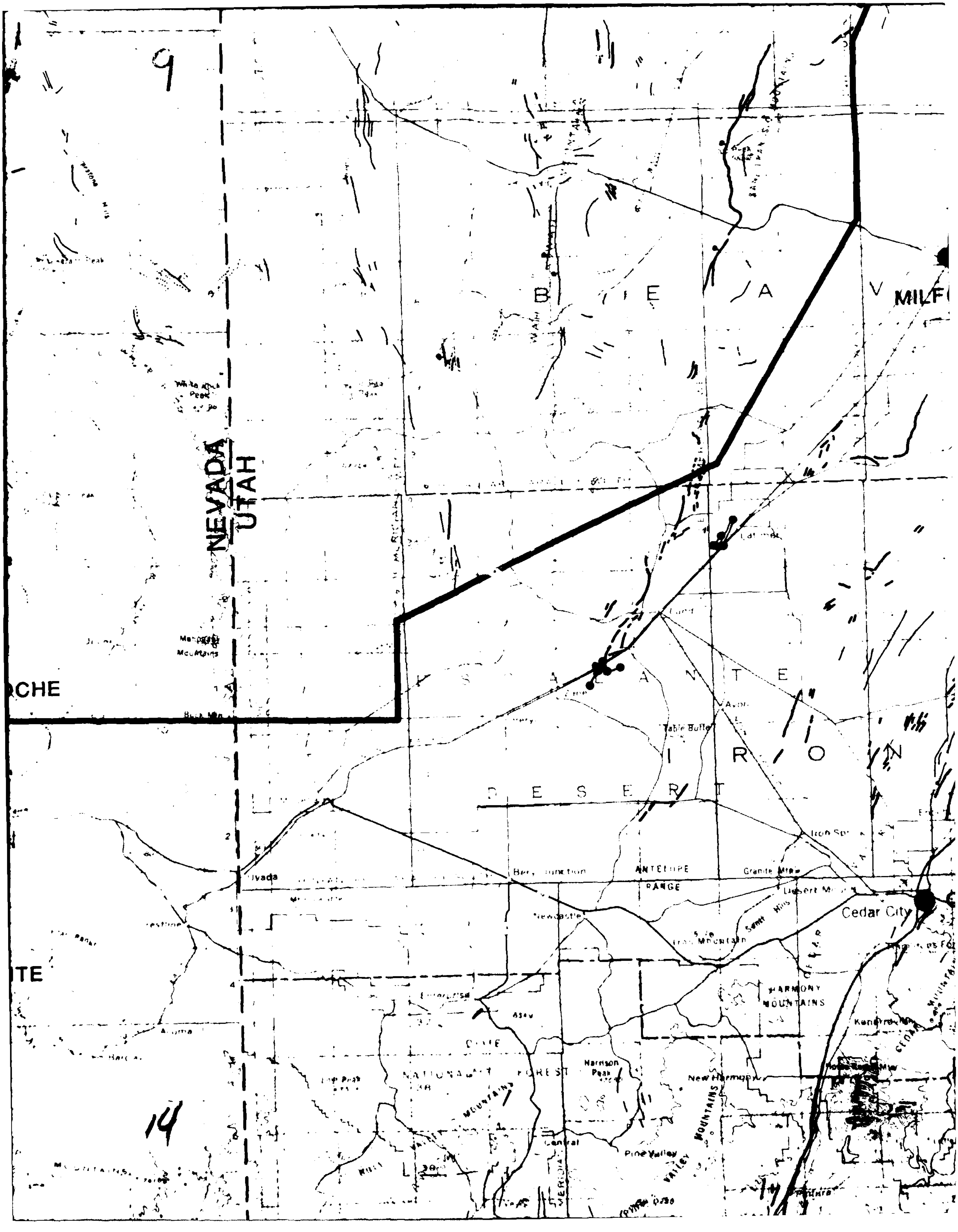


BIG SMOKY VALLEY
TONOPAH
38° 00'
E S M E R A L D A
GOLDFIELD
Piper Mt
Deep Springs
Magruder Mt
Gold Point
Mt Jackson

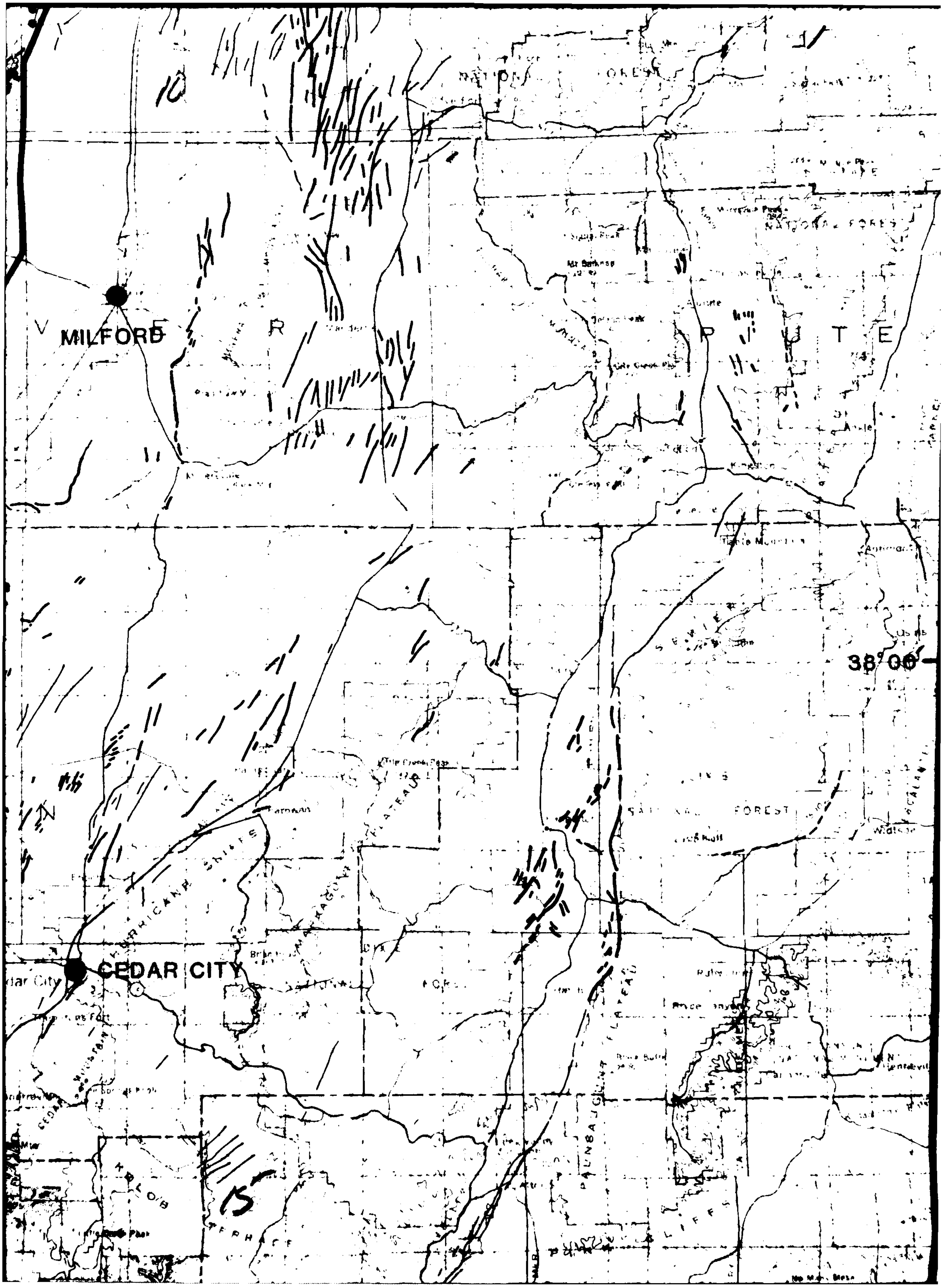

N Y E
EAST RAILROAD V
PENOYER FAULT



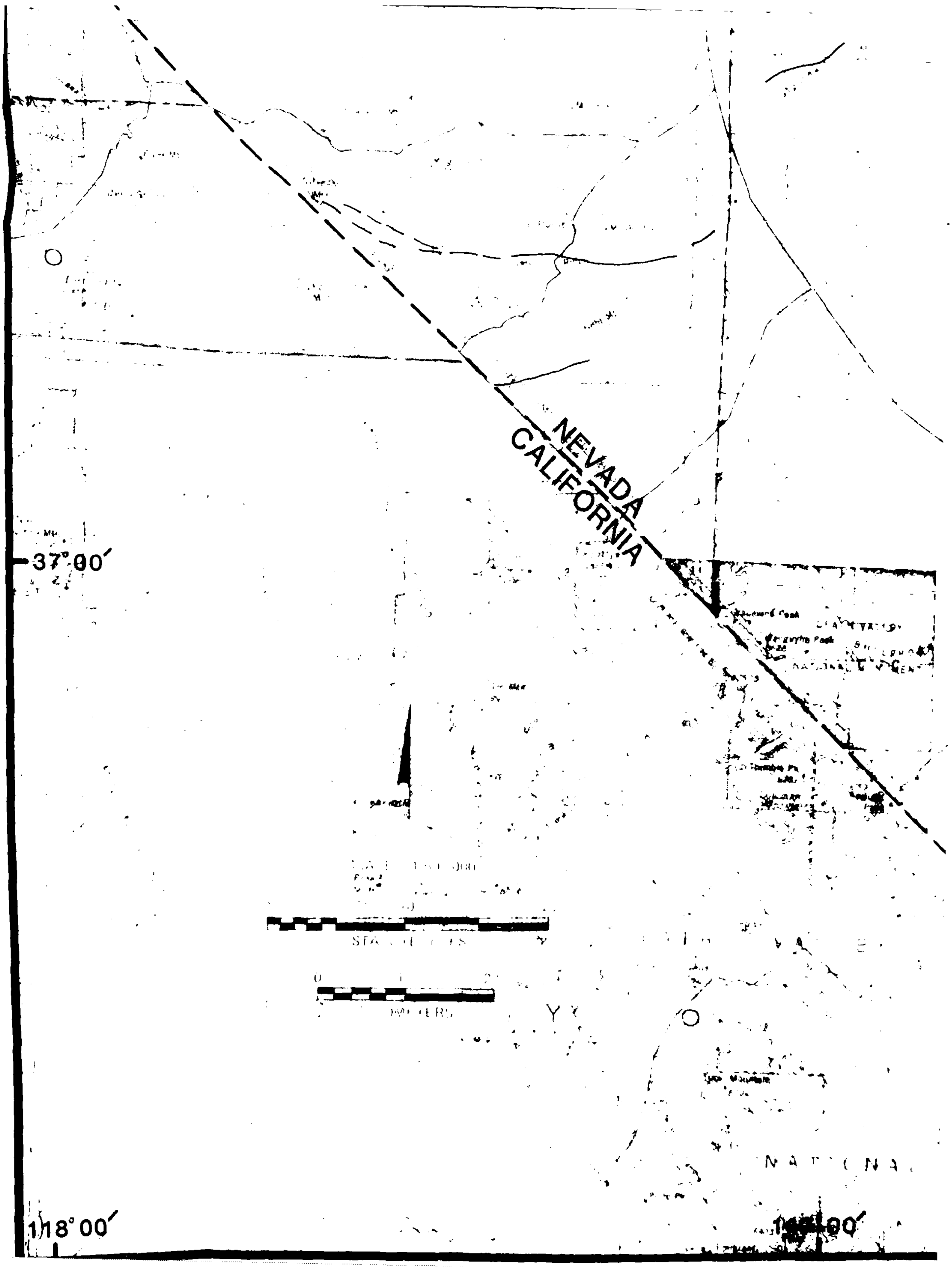
EAST RAILROAD VALLEY FAULT
EGAN FAULT
GOLDEN GATE FAULT
FREIBERG FAULT
PENOYER FAULT
DRY LAKE FAULT
PAHROC FAULT
PIOCH
CALIENTE
13
ONE



9
NEVADA
UTAH
B E A V
MILF
RCHE
Lund
Avon
Table Butte
I R O N
D E S E R T
Uvada
Beryl Junction
ANTELOPE
RANGE
Granite Mtn
Iron Springs
Newcastle
Iron Mountain
Cedar City
HARMONY
MOUNTAINS
TE
NATIONAL FOREST
Harrison
Peak
New Harmony
Central
Pine Valley
14



MILFORD
CEDAR CITY
38°00'
HURRICANE CLIFFS
NATIONAL FOREST
PAUNSAUGUNT PLATEAU
MARKAGUNT PLATEAU
KOLOB TERRACE
10
15


NEVADA
CALIFORNIA
37°00′
118°00′
STATUTE MILES
METERS

AD-A112 535 FUGRO NATIONAL INC LONG BEACH CA F/G 13/2

EXECUTIVE SUMMARY REPORT - FY80 GEOTECHNICAL SITING INVESTIGATI--ETC(U)

NOV 80 F04704-80-C-0006

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3 of 3

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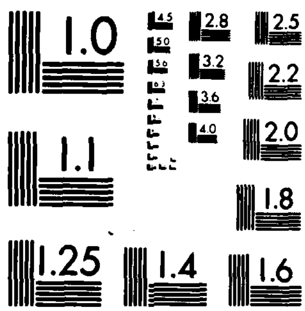
END

DATE FILMED

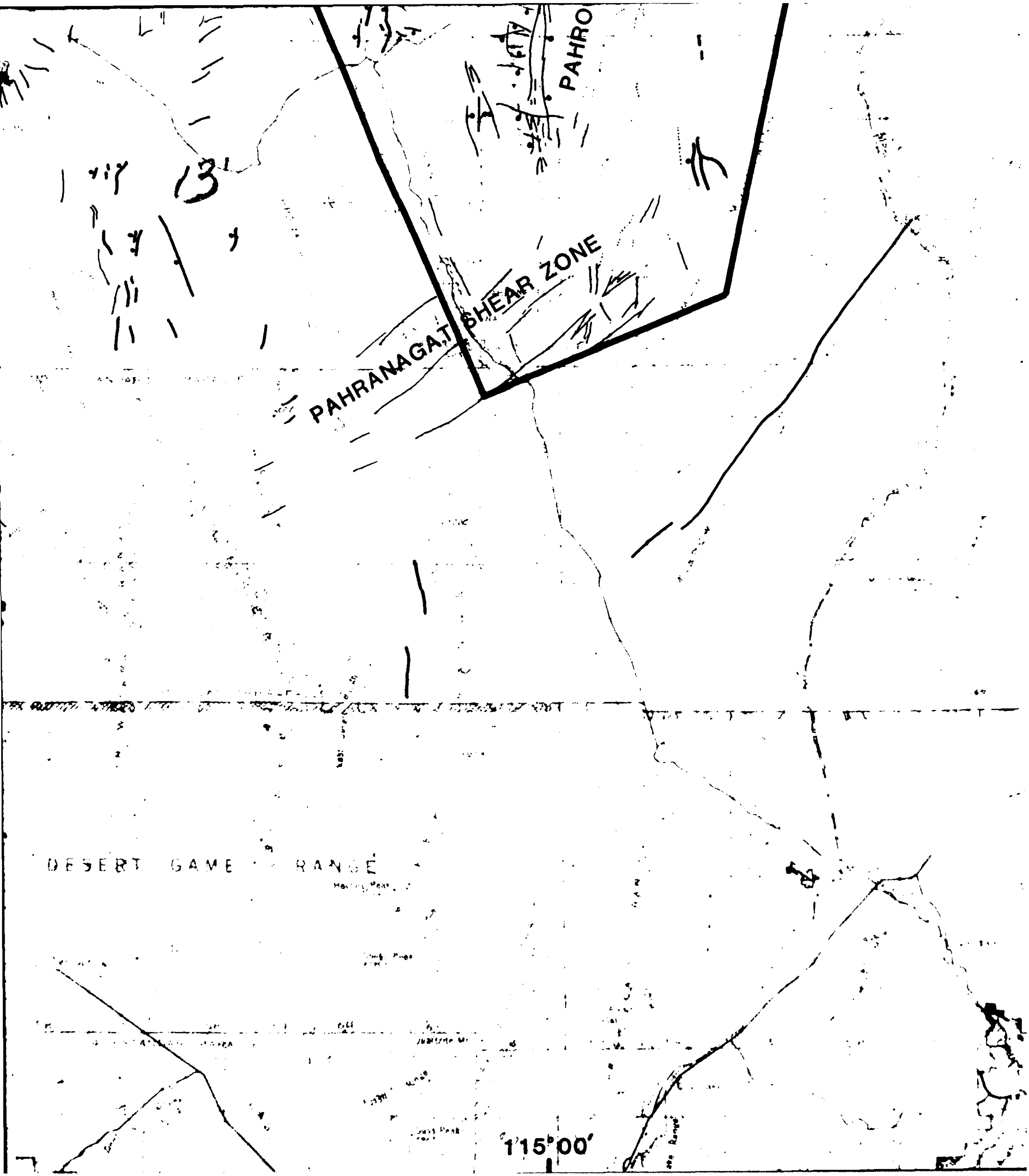
4 82

DTIC

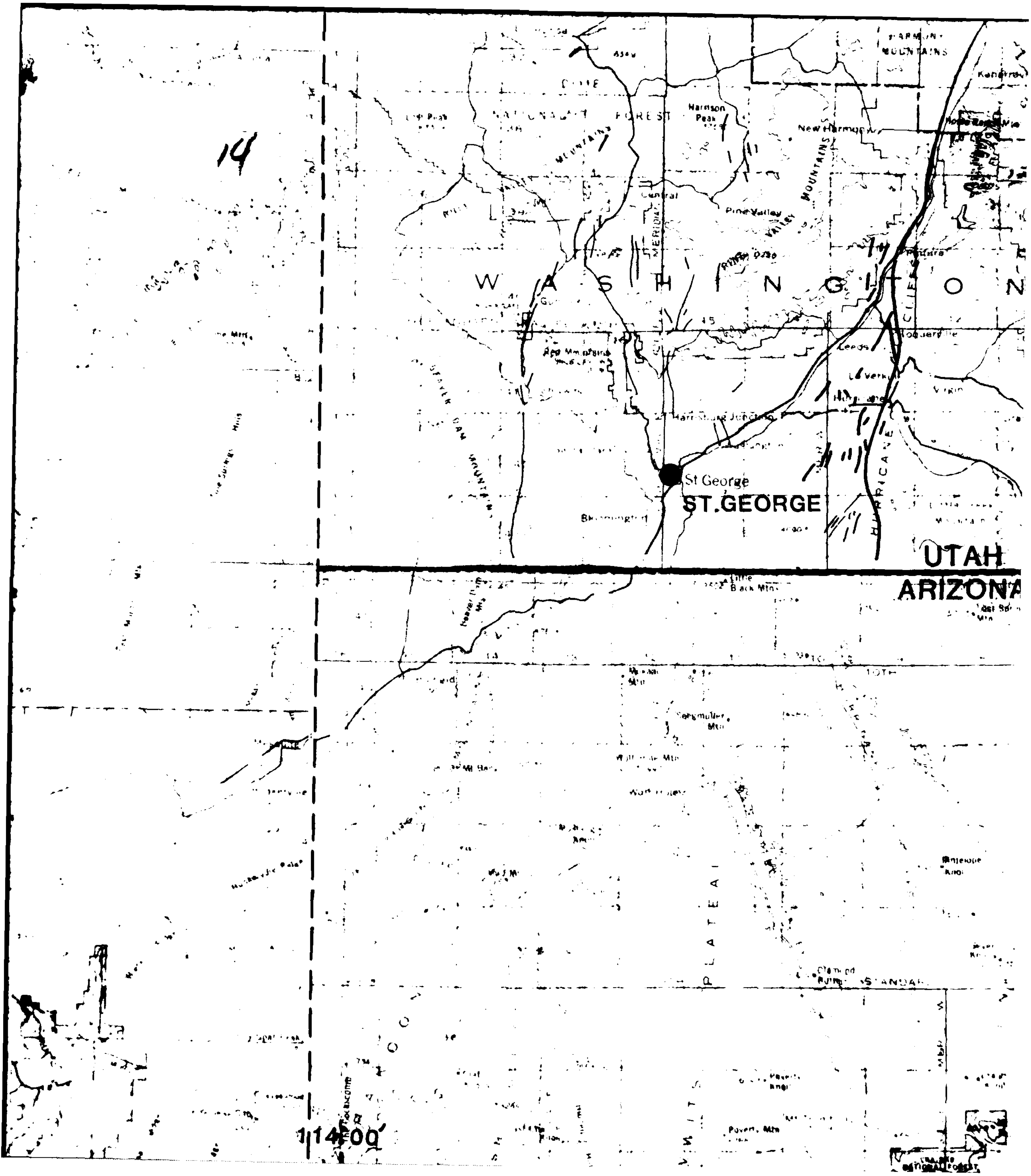


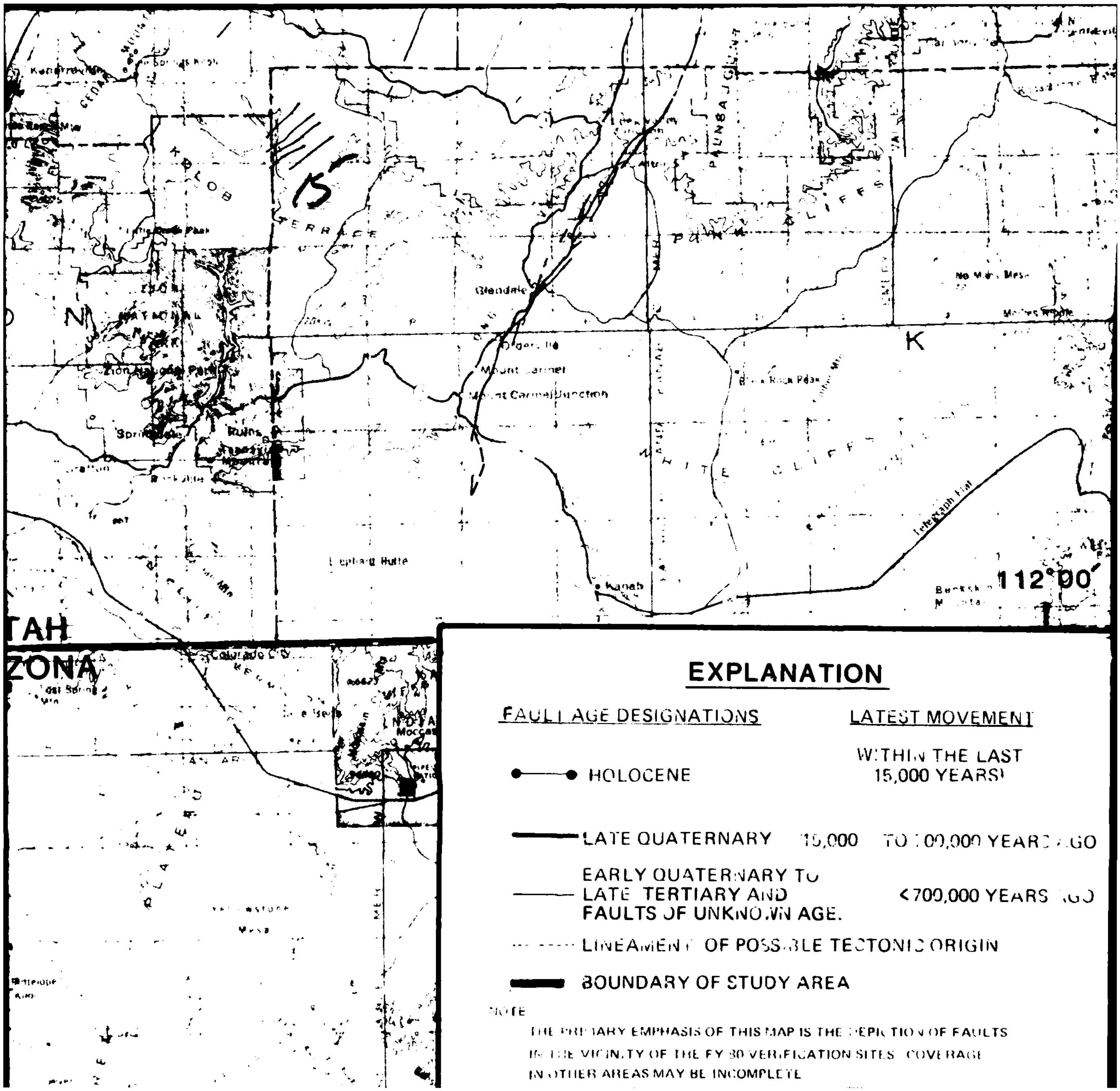
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A


116°00′


PAHRO
13
PAHRANAGAT SHEAR ZONE
DESERT GAME RANGE
115°00′

14


HARMONY MOUNTAINS
DIXIE
NATIONAL FOREST
Harrison Peak
New Harmony
MOUNTAINS
Central
Pine Valley
MERIDIAN
W A S H I N G T O N
St George
ST.GEORGE
Leeds
Hurricane
Virgin
UTAH
ARIZONA
Little Black Mtn
Antelope Knoll
Poverty Mtn
114°00'


KOLOB
TERRACE
15
Glendale
Orderville
Mount Carmel
Mount Carmel Junction
Springdale
Elephant Butte
Kanab
Telegraph Flat
Black Rock Peak
No Mans Mesa
VERMILION CLIFFS
WHITE CLIFFS
PAUNSAUGUNT
N
K
112°00'
TAH
ZONA
EXPLANATION
FAULT AGE DESIGNATIONS
LATEST MOVEMENT
HOLOCENE
WITHIN THE LAST 15,000 YEARS
LATE QUATERNARY
15,000 TO 700,000 YEARS AGO
EARLY QUATERNARY TO LATE TERTIARY AND FAULTS OF UNKNOWN AGE.
<700,000 YEARS AGO
LINEAMENT OF POSSIBLE TECTONIC ORIGIN
BOUNDARY OF STUDY AREA
NOTE
THE PRIMARY EMPHASIS OF THIS MAP IS THE DEPICTION OF FAULTS IN THE VICINITY OF THE FY 80 VERIFICATION SITES. COVERAGE IN OTHER AREAS MAY BE INCOMPLETE

11.0 GRAVITY PROGRAM

11.1 BACKGROUND, SCOPE, AND OBJECTIVES

Gravity surveys have been included in the MX siting investigations since 1977. The gravity data are obtained for the purpose of estimating the gross structure and shape of the basins and the thickness of the valley fill. These estimates are valuable in studying ground-water regimes and for modeling by the MX Survivability and Hardness community. Gravity surveys also have the potential of detecting areas of shallow rock that might be between the widely spaced borings and seismic refraction lines.

Implementation of the gravity program is a joint effort between the Defense Mapping Agency and Fugro National, Inc. The Defense Mapping Agency, Hydrographic/Topographic Center (DMAHTC) performs the field work to obtain the gravity measurements. The Defense Mapping Agency, Aerospace Center (DMAAC) calculates the outer zone terrain corrections for each gravity measurement station and provides existing data from its library. Fugro National calculates inner zone terrain corrections, where needed, and performs geologic interpretations based on the gravity data. Interpretations based on gravity are planned for all of the valleys in the Nevada/Utah Designated Deployment Area.

11.2 STATUS OF FIELD SURVEYS AND REPORTS

Prior to FY 80, gravity data have been acquired or were available for 11 valleys in the Nevada/Utah siting area.

Reports presenting the interpretations from these data were prepared in 1980. In some of these valleys, data were obtained along widely spaced profiles; in others they were obtained on an approximately evenly distributed grid. The status of the gravity field work as of 30 September 1980 is summarized in Table 11-1.

Field work in FY 80 was planned for 20 new valleys with supplemental work in four of the valleys which only had profile data. Field work in eight more valleys is planned for FY 81.

The status of reports covering the gravity surveys is shown in Table 11-2. Twelve reports are planned for FY 81 and nine for FY 82.

11.3 RESULTS OF FY 80 PROGRAM

The gravity interpretations have demonstrated a wide diversity in the depths, shapes, and complexity of structure in the basins in Nevada and Utah. Relatively wide, shallow pediments are interpreted along the flanks of some valleys, whereas the bedrock in others appears to be at great depth very near the rock outcrop lines. Some valleys are symmetrical in cross section, appearing to be true grabens; others are asymmetrical as though formed by tilted blocks. Many faults are interpreted to be trending across the dominant north-south orientation of the Basin and Range structures.

FINISHED*		IN PROGRESS (GRIDS) 1980	PLANNED (1981)
GRIDS	PROFILES (1979)		
DRY LAKE (1978)	BIG SMOKY	ANTELOPE	BUTTE
DUGWAY (1980)	COAL	o CAVE	GARDEN
PINE (1980)	GARDEN	COAL	JAKES
RALSTON (1978)	HAMLIN	o DELAMAR	KOBEH
SEVIER DESERT (1980)	SNAKE EAST	FISH SPRINGS FLAT	LONG
WAH WAH (1980)	WHIRLWIND	o HAMLIN	MONITOR
	WHITE RIVER	o LAKE	NEWARK
		LITTLE SMOKY	STONE CABIN
		o MULESHOE	
		PAHROC	
		RAILROAD	
		PENOYER	
		REVEILLE	
		o SEVIER LAKE	
		o SPRING	
		o SNAKE	
		o STEPTOE	
		o TULE	
		o WHIRLWIND	
		o WHITE RIVER	

* STATION CARDS RECEIVED BY FUGRO NATIONAL AS OF 10 SEP 1980
o SUBSTANTIAL FIELD WORK COMPLETED BY 22 AUG 1980

GRAVITY FIELD WORK STATUS

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE – BMO

TABLE 11-1

FUGRO NATIONAL, INC.

ISSUED	PLANNED (1981)	(1982)
BIG SAND SPRINGS (LIBRARY DATA)	DELAMAR	ANTELOPE
BIG SMOKY	DUGWAY	BUTTE
DRY LAKE	CAVE	COAL
COAL (PROFILES)	MULESHOE	FISH SPRINGS FLAT
GARDEN (PROFILES)	PAHROC	GARDEN
HAMLIN (PROFILES)	PENOYER	HAMLIN
HOT CREEK (LIBRARY DATA)	PINE	JAKES
RALSTON	SEVIER DESERT	KOBEH
SNAKE EAST (PROFILES)	STEPTOE	LAKE
WHIRLWIND (PROFILES)	SNAKE	LITTLE SMOKY
WHITE RIVER (PROFILES)	TULE	LONG
	WAH WAH	MONITOR
		NEWARK
		RAILROAD
		REVEILLE
		SEVIER LAKE
		STONE CABIN
		WHIRLWIND
		WHITE RIVER

GRAVITY REPORTS

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE — BMO

TABLE 11-2

FUGRO NATIONAL, INC.

12.0 OTHER GEOTECHNICAL PROGRAMS

12.1 ROAD DESIGN METHODOLOGY STUDIES

Road Design Methodology studies started in the last quarter of FY 80. The MX system will have more than 7000 miles (11,300 km) of operational roads on which the missile transporter, weighing about 1.6 million pounds (.72 million kilograms), will be shuttling missiles from one shelter to another. The present state-of-art design methodology does not extend to roads subjected to such high loads as those of the missile transporter. Therefore, a new road design methodology will have to be developed. Work related to the new design methodology was initiated in July 1980. It consists of a mechanistic approach in which the stress-strain and failure properties of pavement and in situ soils are characterized by laboratory and field tests, and the performance of the selected pavement sections evaluated through numerical analyses simulating the loading arising from the vehicle. The response of the pavement is then assessed from computed resilient and permanent deformations and comparisons with predetermined design criteria. Laboratory tests, as well as assessment and refining of computer analytical programs suitable for the mechanistic approach, started in FY 80.

12.2 MOBILITY TEST STUDIES

Geotechnical studies at four test tracks in Nevada Test Site were performed to support the mobility test studies planned by Boeing Aerospace Corporation as part of MX missile transporter design. The studies consisted of both field and laboratory

investigations. The field investigation consisted of cone penetrometer tests (CPTs), test pits, and in situ field density and moisture content tests. The laboratory testing consisted of classification, compaction, relative density, California Bearing Ration (CBR), and shear strength tests. The mobility tests consisted of a Terex 33-15 vehicle traversing the test tracks. This vehicle was equipped with 50/42 T tires inflated to 95 pounds per square inch (psi) (655 kilopascals; kPa) pressure; the wheel load was 65 kips (276 kilonewtons; kN) and tire footprint was 19 inches by 42 inches (48 cm by 107 cm). Following the mobility tests, CPTs were again performed to determine the changes in soil strength. The results of the studies were presented in a progress report in August 1980.

13.0 FY 81 GEOTECHNICAL PROGRAM

The FY 81 Geotechnical Program will consist of continuing the programs started in FY 79 and FY 80 in the Nevada/Utah siting area. The major programs scheduled for continuation in FY 81 are: Verification, Water Resources, and Aggregate Resources. Other programs that are also scheduled for FY 81 are: Topographic Mapping, Shelter Layouts, Field Surveys, Operational Base Studies, Mineral Resources, Fault and Earthquake Hazards Evaluation, Gravity Interpretation, and Road Design studies. All of these programs are described briefly in the following sections.

13.1 VERIFICATION

Verification studies will continue in the following 12 valleys in FY 81: Antelope, Little Smoky, Reveille, Stone Cabin, Ralston, Big Smoky, Jakes, Newark, Butte, Long, Kobeh, and Monitor. It is also planned to submit Verification reports for nine valleys which were investigated in FY 80.

13.2 WATER RESOURCES

The Water Resources Program will consist of continuing a number of programs which were started in FY 79 and FY 80. The programs are:

- Shallow aquifer reconnaissance of Jakes, Long, Butte, Newark, Kobeh, and Monitor valleys;
- Drilling and testing of three shallow (<500 feet; <152 m) well sets, two intermediate (>500 feet) well sets, and one deep (>2,000 feet [>610 m]) carbonate well set in the DDA;

- Development of a water management plan for the valleys in the DDA and submittal of a report in September 1981; and
- Data compilation and preparation of a progress report in January 1981 and a technical summary report in July 1981.

13.3 AGGREGATE RESOURCES PROGRAM

Valley-specific and detailed aggregate resources studies will be performed in FY 81. The valley-specific studies will be performed in Steptoe and Cave valleys and the detailed studies will be carried out in Dry Lake, Muleshoe, Delamar, Pahroc, Pine, and Wah Wah valleys. Valley-specific reports will be submitted for nine valleys investigated in 1980 and reports will also be submitted for the five valleys in which detailed studies will be performed in 1981.

13.4 TOPOGRAPHIC MAPPING

It is planned to produce topographic maps for Hamlin and Lake valleys at a scale of 1:9600 with 10-foot (3-m) contours. It is also planned to produce topographic maps at the same scale for candidate operational base sites at Coyote Spring, Beryl, and Milford. Field surveys will be performed at the Delta and Ely sites, but no maps will be made unless such instructions are given at a later date.

13.5 SHELTER LAYOUTS

It is expected that shelter layouts at a scale of 1:62,500 will continue for the first half of FY 81 or until the cutoff date for land withdrawal. The layouts will continue to be updated as new information is received regarding suitable area, land

status, cultural conditions, environmental impacts, and geotechnical conditions. When a final version of a valley layout is completed, legal descriptions will be prepared for all MX structures to be included in the land withdrawal. It is also planned to prepare detailed layouts at a scale of 1:9600 for those valleys where maps at this scale have been made.

13.6 FIELD SURVEYS, IOC VALLEYS

It is planned to complete the field surveys in Pine and Wah Wah valleys. The procedures are the same as for Dry Lake Valley as described in Section 7.0. The field work should be completed in January or later, depending on weather conditions. A report will be submitted about two months after completion of field work.

13.7 OPERATIONAL BASE STUDIES

Geotechnical studies, water resource studies, mineral surveys, and environmental surveys are planned at the candidate operational base sites at Coyote Spring, Beryl, and Milford. The mineral and environmental surveys will also be performed at the Delta and Ely sites.

The geotechnical studies will be comparable to the Verification field program and include the following activities at each site:

- Photogeologic mapping and field checks;
- Ten to 15 borings;
- Fifty to 70 cone penetrometer tests;
- Twenty to 30 test pits;

- o Six to eight trenches; and
- o Fifteen to 20 seismic refraction and electrical resistivity soundings.

The Water Resources Program will consist of the following activities:

- o Shallow aquifer reconnaissance studies of all three OB sites;
- o Shallow aquifer drilling and testing of one well set at each of the three OB sites; and
- o Drilling and testing of one carbonate well set at the Coyote Spring OB site.

A mineral resources survey is to be performed at all five OB sites. The study is to include the following tasks:

- o Inventory all mining claims, state and federal leases, and nonfederal fee ownerships;
- o Review past and present mining activity;
- o Determine potential for mineral resource occurrences;
- o Examine on-site any reported or projected mineral occurrences; and
- o Define the extent of past or present exploration.

An environmental survey will be performed for the OB sites. An overview of the cultural and biological resources will be performed for all five sites by searching the literature and records. Field reconnaissance studies will be carried out at the Coyote Spring, Beryl, and Milford sites to check known resource areas and sample unknown areas.

13.8 ACTIVE FAULT AND EARTHQUAKE HAZARDS STUDY

The Active Fault and Earthquake Hazards Study that was started in FY 80 will continue into FY 81. Studies will be performed

in the six northern valleys which were not previously investigated. Aerial photo interpretation is used to delineate fault traces, and field verification is achieved by field reconnaissance. Other fault studies will include:

- o Ground-magnetometer surveys along some photo linear features to aid in determining if the feature is fault-related or due to some other cause; and

- o Additional observations of fault-scarp morphology of several longer faults to aid in characterizing rupture lengths and displacements.

13.9 GRAVITY DATA ANALYSIS

Gravity data analysis and submittal of reports will continue in FY 81. Gravity field measurements will continue to be obtained by the DMA. The number of valleys analyzed by Fugro National will depend on the amount of data received from DMA; it is estimated that gravity data will be available for 12 valleys. It is planned to submit about one report per month.

13.10 ROAD DESIGN STUDIES

Road design studies are a continuation of studies that were started in the last quarter of FY 80. The studies include a laboratory testing program on five soil types which represent the broad range of soils found in the deployment area of Nevada and Utah. The tests will be performed to determine the physical and engineering properties of each soil type. The test data will be used in a finite element computer program to predict road characteristics and factors of safety against failure for various design sections.

APPENDIX A

Fugro National Inc.
Technical Reports

FUGRO NATIONAL, INC. TECHNICAL REPORTS

FN-TR-1 Fugro National, Inc., 1975a, Siting evaluation report: Cons. report for SAMSO, v. I, 55 p., app.

TR-2 __________, 1975b, Geotechnical report, White Sands Missile Range/Fort Bliss Military Reservation: Cons. report for SAMSO, v. IIA, 113 p., data summary sheets, app. and graphics volume.

TR-3 __________, 1975c, Geotechnical report, Yuma Proving Grounds/Luke-Williams Bombing and Gunnery Range: Cons. report for SAMSO, v. IIB, 122p., data summary sheets, app. and graphics volume.

TR-4 __________, 1975d, Geotechnical report, Nellis Bombing and Gunnery Range: Cons. report for SAMSO, v. IIC, 125 p., data summary sheets, app. and graphics volume.

TR-5 __________, 1975e, Recommended geotechnical field investigation: Cons. report for SAMSO, v. III, 45 p.

TR-6 __________, 1975f, Environmental assessment report: Geotechnical field investigation: Cons. report for SAMSO, v. IV, 165 p., app.

TR-7 __________, 1975g, Water rights and resources: Cons. report for SAMSO, 104 p., app.

TR-8 __________, 1975, Comparative environmental assessment of the three MX land mobile missile system concepts: Cons. report for SAMSO, 179 p., app.

TR-9 __________, 1976a, Siting evaluation report: Cons. report for SAMSO, v. I, 63 p., app.

TR-10 __________, 1976b, Geotechnical report, White Sands Missile Range Extension: Cons. report for SAMSO, v. IIA, 88p., data summary sheets, app. and graphics volumes.

TR-11 __________, 1976c, Geotechnical report, Gila Bend Group: Cons. report for SAMSO, v. IIB, 120 p., data summary sheets, app. and graphics volume.

TR-12 __________, 1976d, Geotechnical report, Nellis Group: Cons. report for SAMSO, v. IIC, 142 p., data summary sheets, app. and graphics volume.

FUGRO NATIONAL, INC. TECHNICAL REPORTS

FN-TR-13 Fugro National, Inc., 1976e, Recommended geotechnical field investigations: Cons. report for SAMSO, v. III, 79 p., app.

TR-14 __________, 1976f, Multiple aim-point validation (MAV) program, Luke Bombing and Gunnery Range, Arizona. Part 1 - Site selection and surficial geology, Part 2 - Soils engineering and seismic refraction: Cons. report for SAMSO, 63 p.

TR-15 __________, 1976g, MX siting regions evaluations: Delineation and analysis of suitable Department of Defense and Bureau of Land Management lands: Cons. report for SAMSO, 51 p., app.

TR-16 __________, 1977a, MX siting investigation conterminous United States, v. I coarse screening: Cons. report for SAMSO, v. I, 30 p., app.

TR-17 __________, 1977b, MX siting investigation geotechnical evaluation conterminous United States, v. II intermediate screening: Cons. report for SAMSO, v. II, 175 p., app.

TR-ST __________, 1977c, MX siting program soil temperature determination, Luke Bombing and Gunnery Range, Arizona: Cons. report for SAMSO, in progress, 32 p., app.

TR-18 __________, 1977d, Geotechnical report Mohawk - Tule Valley, Arizona: Cons. report for SAMSO, v. I and II, 141 p., app.

TR-WR __________, 1977e, Evaluation of water resources in vicinity of Stoval Field, San Cristobal Valley, Yuma county, Arizona: Cons. report for SAMSO, 42 p., app.

TR-19 __________, 1978a, Geotechnical report Lechuguilla Desert, Arizona: Cons. report for SAMSO, v. I and II, 147 p., app.

TR-GE __________, 1978b, General geotechnical site feasibility analysis for the environmental assessment of an MX test facility, Vandenberg Air Force Base, California: Cons. report for SAMSO, 29 p., app.

TR-20 __________, 1978c, Aggregate resources report Department of Defense and Bureau of Land Management lands, southwestern United States (draft): Cons. report for SAMSO, 74 p., app.

FUGRO NATIONAL, INC. TECHNICAL REPORTS

FN-TR-21 Fugro National, Inc., 1978d, Geotechnical investigation Misers Bluff Test Program Planet Ranch Test Valley, Arizona (draft): Cons. report for SAMSO, 52 p., app.

TR-21A __________, 1978, Crosshole velocity survey, Misers Bluff ground zero-2 (GZ-2) Planet Ranch Test Valley, Arizona.

TR-22 __________, 1978e, MX siting investigation geotechnical evaluation trench layout report (draft): Cons. report for SAMSO, 39 p., app.

TR-23 __________, 1978f, Geotechnical investigation methodology report MX siting investigation western conterminous United States (draft): Cons. report for SAMSO, 67 p., app.

TR-24 __________, 1978g, MX siting investigation conterminous United States, V. III fine screening: Cons. Report for SAMSO.

TR-25 __________, 1978h, MX siting investigation, geotechnical evaluation, geotechnical ranking of seven candidate siting regions report.

TR-26a __________, 1978i, MX siting investigation, geotechnical summary, prime characterization sites, Central High Plains Candidate Siting Province report.

TR-26b __________, 1978j, MX siting investigation, geotechnical summary, prime characterization sites, Southern High Plains Candidate Siting Province report.

TR-26c __________, 1978k, MX siting investigation, geotechnical summary, prime characterization sites, Rio Grande/Highlands Candidate Siting Province report.

TR-26d __________, 1978l, MX siting investigation, geotechnical summary, prime characterization sites, Sonoran Candidate Siting Province report.

TR-26e __________, 1978m, MX siting investigation, geotechnical summary, prime characterization sites, Great Basin Candidate Siting Province report.

TR-BT __________, 1978n, Geotechnical report, shear strength of compacted backfill, break-out and erection tests, MAV test site, San Cristobal Valley, Arizona, 51 p.

FUGRO NATIONAL, INC. TECHNICAL REPORTS

FN-TR-BT Fugro National, Inc., 1978o, Geotechnical siting status report: Cons. report for SAMSO; v. I, 242 pages, v. II, 13 maps, app.

TR-27 __________, 1979a, Nevada-Utah verification studies, FY 79: Cons. report for SAMSO; v. IA 221 pages, v. I (B 122 p. app.; v. II through VIII, data v. with about 15 tables, 75 figs., and 4 drawings in each volume.

TR-28 __________, 1979b, Arizona verification studies, FY 79: Cons. report for SAMSO; v. I, data volume with 13 tables, 17 figs., and 13 drawings; v. II, data volume similar to v. I.

TR-29 __________, 1979c, Thermal properties of soils, 137 p., 59 figs., 9 tables, and 13 plates.

TR-30 __________, 1979d, Executive summary report, geotechnical siting investigation FY 79, 74 p., 20 figs., 6 tables, 5 photographs.

TR-RP __________, 1979e, Railroad pass evaluation, Nevada-Utah Siting Area, 21 p., 2 figs., 1 table, 3 photos, 2 drawings.

TR-31 __________, 1979f, Alternative energy sources for the MX System, Nevada-Utah (draft); 520 p., 24 figs.

TR-33-WW __________, 1980a, Gravity survey - Whirlwind Valley, Utah; 32 p., 8 figs.

TR-33-HV __________, 1980b, Gravity survey - Hamlin Valley, Nevada; 33 p., 13 figs.

TR-35 __________, 1980c, (1) Proposed operational base site, Coyote Spring and Kane Springs Valleys, Nevada; 41 p., 7 figs., 2 tables, 3 drawings. (2) Proposed operational base site, Escalante Desert, Milford Area, Utah; 39 p., 7 figs., 3 tables, 3 drawings. (3) Proposed operational base site, Steptoe Valley, Ely Area, Nevada; 38 p., 5 figs., 3 tables, 3 drawings.

TR-32 __________, 1980d, MX siting investigation, shelter layout study; 30 p., 1 fig., 8 tables, 7 drawings.

TR-WS __________, 1980e, Evaluation of screening results and geotechnical conditions state of Wyoming; 26 p., 6 figs., 1 table.

FUGRO NATIONAL, INC. TECHNICAL REPORTS

FN-TR-34 Fugro National, Inc., 1980f, Aggregate resources report, Utah-Nevada Study Area; 99 p., 3 figs., 35 tables, 6 photos, 2 drawings.

TR-27-DL ___________, 1980g, Verification study, Dry Lake Valley, Nevada; v. I - synthesis, 90 p., 11 figs., 11 tables, 7 drawings; v. II - geotechnical data, 28 p., 86 figs., 21 tables, 6 drawings.

TR-33-DL ___________, 1980h, Gravity survey - Dry Lake Valley, Nevada; 47 p., 7 figs.

TR-36 ___________, 1980i, Interim report on active faults and earthquake hazards in the FY 79 verification sites - Nevada-Utah siting region; 72 p., 2 figs., 5 drawings.

TR-33-SV ___________, 1980j, Gravity survey - Southern Snake Valley (Ferguson Desert), Utah; 28 p., 11 figs.

TR-37 ___________, 1980k, Valley-specific aggregate resources study:
a. Dry Lake, Muleshoe, Delamar, Pahroc Valleys; 45 p., 6 figs., 3 tables, 2 drawings.
b. Snake Valley; 47 p., 9 figs., 3 tables, 2 drawings.
c. White River Valley; 44 p., 7 figs., 3 tables, 2 drawings.
d. Whirlwind Valley; 43 p., 5 figs., 3 tables, 2 drawings.
e. Hamlin Valley; 44 p., 6 figs., 3 tables, 2 drawings.

TR-38 ___________, 1980l, Water resources program summary for draft environmental impact statement, v. I; 151 p., 4 figs., 6 tables; Water resources program summary for draft environmental impact statement, V. II; 8 tables.

TR-33-WR ___________, 1980m, Gravity survey - Southern White River Valley, Nevada; 23 p., 8 figs., 1 table, 1 drawing.

TR-33-GN ___________, 1980n, Gravity survey - Garden Valley; 13 p., 6 figs., 1 drawing.

TR-33-CV ___________, 1980o, Gravity survey - Coal Valley; 14 p., 6 figs., 1 drawing.

FUGRO NATIONAL, INC. TECHNICAL REPORTS

FN-TR-DTN Fugro National, Inc., 1980p, Preliminary evaluation of designated transportation network; 22 p., 3 figs., 6 tables, 9 drawings.

TR-38 __________, 1980q, MX siting investigation water resources program summary for the DEIS; v. I, II, III, 151 p., 4 figs., 6 tables, 12 app.

TR-39 __________, 1980r, Summary of suitable area Nevada-Utah, verification studies, FY 79 and FY 80, v. I; 12 p., 4 tables, 13 drawings; Summary of suitable area Nevada-Utah, verification studies, FY 79 and FY 80, v. II; 7 drawings.

TR-ETB-1 __________, 1980s, Progress report, geotechnical study for mobility test tracks, ETB mobility study, Nevada Test Site, Nevada; 35 p., 7 tables, 3 app., 13 figs.

TR-40 __________, 1980t, MX siting investigation water resources program interim report; 94 p., 3 figs., 5 tables, 9 app.

TR-41D __________, 1980u, MX Mineral resources survey, Nevada/Utah siting area (draft), v. I-XI, 311 p., 3 app.

TR-42 __________, 1980v, Executive Summary.

OTHER TECNICAL REPORTS WITHOUT TR NUMBERS

1. Fugro National, Inc., 1979, MX siting investigation geotechnical summary water resources program, FY 79; 54 p., 2 figs., 3 tables, 12 drawings, 3 app.

2. __________, 1980a, MX siting investigation, Nevada and Utah water law and procedures for rights acquisition, water resources program FY 80; 5 p., 2 tables, 1 app.

3. __________, 1980b, Municipal water-supply and wastewater treatment facilities in selected Nevada and Utah communities; 2 p., 4 tables, 2 app.

4. __________, 1980c, MX siting investigation, water resources program industry activity inventory, Nevada-Utah; 3 p., 1 table, 2 app.

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